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SURGICAL DISEASES

OF THE

KIDNEY AND URETER

INCLUDING

INJURIES, MALFORMATIONS AND MISPLACEMENTS

BY

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SURGICAL DISEASES OF THE KIDNEY AND URETER.

PART I.—SURGICAL DISEASES OF THE KIDNEY.

(Continued.)

CHAPTER XXII.

TUMOURS OF THE PELVIS OF THE KIDNEY.

Besides the cases of tumours commencing in the capsule, in the parenchyma, or in the sinus of the kidney, and which in process of growth extend into the renal cavity, there are others which unquestionably have had their point of departure in the renal calyces or pelvis.

TUMOURS OF EPITHELIAL ORIGIN.

Pathology.—Carcinoma, myxoma, myxo-sarcoma, lymphatic endothelioma, myo-sarcoma, rhabdo-myoma, as well as papilloma, have each been met with as tumours primarily originating in the pelvis of the kidney, but simple papilloma and epithelioma are the two most common forms of new growth which commence therein.

Not unfrequently the tumour, whether benign or malignant, extends into the ureter. Albarran, in a recent and comprehensive article based on an analysis of forty-two cases of neoplasms of the renal pelvis and ureter,* states that eighteen out of the forty-two cases were papillary growths and thirteen non-papillary epitheliomata. In the former group he includes all growths of epithelial origin which have villous structure, hence they are not all of them simple benign papillomata. In six of the eighteen villous tumours and in five of the thirteen non-papillary epitheliomata, the growths were confined exclusively to the renal pelvis and calyces, and did not extend into the ureter. In five other villous tumours and in three other non-papillary epitheliomata, the growth started in the renal pelvis, but spread into the ureter. The extent to which the ureter is affected varies in different cases; it may be only for an inch or two at the upper end, or it may be for the whole length, or the growth may project through the lower ureteral orifice into the bladder. In some cases of simple villous papilloma the upper and lower ends of the tube are affected, but not the intervening portion. The mucous membrane from the kidney to the bladder may be thickly covered with disseminated villous growth. In some cases the bladder is affected, but not the ureter, by a portion of the growth being carried by the urine and becoming implanted: a graft, indeed, being made just as De Morgan described in a case in which the lower end of the theca of the cord was affected secondarily by a particle of a growth within the skull falling down the dural canal. In a specimen contained in the Musée Dupeytren (Tuffier) a cauliflower-shaped nodule of cylindrical-celled carcinoma occupies the renal pelvis at the upper opening of the ureter, through the centre of which there is a narrow channel into the ureter. From this there extends an inch or more of the ureter unaffected, and below this again the duct forms a cord as thick as the little finger, filled and obliterated by a white cancerous mass. There was no cancer in any other part.

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* *Ann. des Mal. des Organ. Gén.-urin.*, Juillet, 1900, p. 701.

Pathological anatomy.—Primary cancer of the renal pelvis presents nothing distinctive from carcinoma of the pelvis secondary to cancer of the renal parenchyma. Primary epithelioma of the pelvis sometimes has the villous appearance which at first sight to the naked eye makes it appear like simple villous papilloma. Papilloma may be of the villous character or of the more solid pedunculated variety; it may be unilateral or bilateral. It may be free in the midst of the renal pelvis, or spread widely into the calyces, as in an interesting case of Mr. Fenwick's,* in which the pelvis was filled, and the cortex honeycombed with cavities lined with villous growth; it may be disseminated along the ureter as far as the inferior extremity, and even extend into the bladder, or it may involve the mucous membrane of the calyces and pelvis of the kidney and of the inferior extremity without affecting the upper end and the intervening portion of the tube. Detached portions of the growth may occupy the ureter, as in a case in the Middlesex Hospital referred to further on, or project at the vesical orifice, and yet the ureter may be quite uninvaded by the neoplasm.

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* *Med. Soc. Trans.*, vol. xx., p. 237. The preparation is preserved in the Hunterian Museum No. A3584.

Although in some instances what has looked like a benign villous growth has really proved to be a villous epithelioma or a villous sarcoma, yet many cases of villous growths in the renal pelvis are simple papillomatous proliferations of the mucous membrane, resembling the simple villous papillomata frequently met with in the urinary bladder.

Whether the benign tumours ever take on a malignant character used to be considered uncertain, but cannot any longer be doubted. Though the villous epithelioma is probably in most cases malignant from the start, yet Drew's case—in which the growth found in the renal pelvis was an epithelioma with cells of the transitional type, and the growths in the ureter and bladder were simple papilloma—strongly suggests that the primary growth was simple but became malignant, and secondarily affected the liver and lymphatic glands, whereas the ureteral and vesical growths were caused by grafts of detached villous processes before the parent growth became malignant.

One of the commonest effects of a growth in the renal pelvis is renal retention of urine and its consequences, viz. hydronephrosis, with great wasting of the parenchyma and great distension of the cavity. As many of these growths have a pronounced tendency to bleed, hæmato-nephrosis or combined hydro- and hæmato-nephrosis occur. These changes result equally from malignant and benign tumours. Even a small growth, no larger than a pea or a cherry, if situated over the superior ureteral orifice, may cause a vast tumour due to distension with urine or blood, or both. The quantity of retained fluid varies from a few ounces to many pints. In other cases the amount of growth may be so considerable that it adds greatly to the size, or even forms the bulk of the tumour. Such was the case in a male aged twenty-seven in the Middlesex Hospital,* with a large tumour in the region of the left kidney, reaching nearly to the middle line at the umbilicus, and to the anterior superior spine of the ilium below. The mass was too large to be removed through the loin, and so nephrectomy by the combined lumbar and lateral abdominal method was performed by Mr. Kellock. The tumour removed proved to be a large lobulated kidney,

* *Hospital Reports*, 1897, p. 131.

measuring 8½ inches by 5½ inches by 4 inches, and on section the cortical part was found to be only one-eighth of an inch thick, the distended pelvis being occupied by large masses of soft papillomata which sprang from numerous points all over its interior. Microscopically these growths proved to be simple papillomata.

In other cases the renal substance may be unchanged, and the ureter, though apparently the site of new growth, may be perfectly normal. Such was found in the case of a woman aged sixty-five in the Middlesex Hospital,* whose right kidney was removed through a lumbar incision by Mr. Gould, on account of a tumour distending the renal pelvis. On examination of the kidney removed, its substance was found normal; but its pelvis was occupied by a soft papillomatous growth springing from the mucous membrane. The ureter was normal; a piece of the growth seen in its upper end at the time of the operation after removing the kidney had been separated from that in the pelvis of the kidney.

In De Morgan's case,† besides the several small dendritic masses of villous papillomatous new growth, the renal pelvis was filled with what at first sight looked like a thick mass of shreddy pus: this creamy fluid, however, contained no pus corpuscles, but consisted entirely of a fluid loaded with various sized and shaped nucleated cells, granular corpuscles, granules, and *débris* of cells. Though it looked as if this material belonged to a cancerous growth, the villi and the body and pedicle of the growth had the ordinary characters of benign villous papilloma of the bladder; and, though the disease had existed for years, no secondary deposits were found in the body.

Pathogenesis.—Long-standing irritation of the renal pelvis, such as simple or calculous pyelitis, leads to the development of cancer of the renal pelvis as in other cases irritation does to cancer of the cortex.

A calculus lodged in a calyx or in the renal pelvis, there can be no doubt, may be an exciting cause of cancer. The testimony of Wilks and Frerich and the cases mentioned by Shattock, Walsham, and Norman Moore,‡ and others prove this. Transformations of epithelium follow from long-standing inflammation:

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* *Hospital Reports*, 1897, p. 132. The specimen is in the Middlesex Hospital Museum.

† *Trans. Path. Soc. Lond.*, vol. xxi., p. 239 Lond.

‡ *Brit. Med. Journ.*, March 10th, 1888, p. 533.

the normal cells assume an epidermic character, and stratified pavement-epithelium is formed upon a sclerosed sub-epithelial tissue (*see* chapter on "Tumours of the Ureter," (*post*, p. 487). This has been called "urinary leucoplakia," and in some cases this leucoplakia of the renal pelvis or ureter has been the starting point of pavement-celled epithelioma. The more frequent form of carcinoma of the renal pelvis is the alveolar; less frequently cylindrical-celled epithelioma occurs, which very often has a papillary character. But although these changes in the mucous membrane of the renal cavity and the ureter are not uncommon, primary cancer of these parts is very rare.

Papillomatous tumours, according to Henle, are developed from pre-existing papillæ. Virchow considers that all epithelium can give birth to papillæ, whether such exist normally in the mucous membrane of the part or not. There is also a difference of opinion as to whether they are due to a development primarily of the capillaries, or whether, on the contrary, the appearance of new-formed vessels is not preceded by a proliferation of connective tissue followed by a development of the blood vessels. Inflammation of the mucous membrane is the cause of the changes which lead to these growths. A papillomatous proliferation or "villous pyelitis" precedes the formation of the villous form of papilloma. A simple irritation of the epithelial tissue may result in a simple fibrous papilloma. In support of the view that these growths are due to inflammation is the fact that in some cases the neoplasms are everywhere mixed with inflammatory tissue tending in places even to suppuration.

Calculus is an exciting cause of villous papilloma, as well as of carcinoma and sarcoma. Drew, in describing before the Pathological Society* a case of villous carcinoma of the renal pelvis, ureter, and bladder, causing hydro-nephrosis, in a man aged fifty-six, refers to eight cases of villous growth, in four of which there were no calculi, while in four there were.

In the first group are (1) Murchison's case in a man aged sixty-five and (2) De Morgan's case in a woman aged seventy-six, both well-known cases; (3) a case for which Billroth performed nephrectomy on a patient aged thirty-three; and (4) a man aged fifty-five, in whose kidney was found a growth which was removed by Mr. Jones of Manchester with a sharp spoon, but nephrectomy for recurrence of the growth was requisite nine months later.

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* *Trans.*, vol. xlviii., p. 130 (1897).

In the second group—papilloma with calculus—are (1) Battle's case, in a man aged fifty-one. Nephro-lithotomy was performed, several round dark-coloured stones were removed, and the villous growth was scraped away. Nephrectomy was necessary eighteen months later, on account of profuse hæmorrhage extending over several months. An abscess, two or three small calculi, and a return of the growth were found at the second operation. The original villous tumour is described as being an epithelioma.

(2) Knowsley Thornton's case was that of a female aged thirty-two, on whom nephrectomy was performed for hydronephrosis due to a single papillomatous growth at the junction of the ureter and renal pelvis; the growth was the size of a pea, with a calculus upon and adherent to it.

(3) A specimen in Guy's Museum.

(4) A specimen in University College Museum in which there are four growths.

In three of the first group the papilloma was diffused, and in one single; in three of the second group it was single, and in one multiple. In the Guy's case, referred to in Dickinson's work, there was a large amount of villous growth, which Dickinson submitted to a careful microscopical examination and found to be sarcoma. Its apparent origin was due to calculous irritation. Thornton thought the calculus in his case was secondary to the growth because the calculus was hollowed out and intimately adherent to the growth. Israel, Hartmann, and Kundrat have all recorded cases of carcinoma associated with calculus.

The museum of King's College contains a specimen in which a melanotic tumour co-exists with a villous growth within the kidney.

LYMPHO-SARCOMA.

A case has been described by C. P. White* in which the mucous membrane of the pelvis and calyces of the kidney of a child aged six was the seat of a firm red mass of lympho-sarcoma which did not invade the kidney substance but extended down along the course of the ureter and spread outwardly behind the suprarenal capsule and across the spinal column to the opposite kidney. There were secondary deposits in the intestines, mesentery, and lesser omentum. There had been no symptoms pointing to the kidney, and the kidney itself was not enlarged.

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* *Trans. Path. Soc.*, vol. xlix., p. 178.

CYSTS.

Cysts sometimes occur in the renal pelvis as well as in the ureter. Voelcker showed at the Pathological Society in 1897,* the kidneys from a man aged seventy-three, who died of uræmia; both organs were the seat of chronic interstitial nephritis with cysts. The right was very small, weighing only two ounces. The left, in addition to numerous cysts in its substance, had several cysts in its pelvis; and others were present in the left ureter, which was double in the upper five inches of its extent. Psorosperms, due to coccidia, have been found in the renal pelvis.

TUMOURS OF THE RENAL PELVIS GENERALLY.

Diagnosis.—Renal growths from the capsule or parenchyma, calculus, tubercle, and nephrectasis from various causes are the diseases likely to be mistaken for a tumour of the renal pelvis. It is unnecessary to repeat what has been previously said as to the diagnosis of renal growths from calculus, tubercle, and nephrectasis. It will be rarely possible to distinguish clinically between tumours primarily of the renal pelvis and those commencing in some other part of the organ. Neither the characters of the abdominal tumour, of the hæmaturia, of the pain (or absence of pain), or of the urine will suffice to enable us to decide whether the new growth is primarily of the renal pelvis or ureter or the kidney, even when we have rightly diagnosed that the cause of the symptoms is a neoplasm. We have seen that the abdominal tumour caused by a new growth in the renal pelvis may be due either to the great size of the growth itself or to renal retention—hydro-nephrosis or hæmato-nephrosis. When due to the growth itself, nothing in the outline of the tumour or mode or rate of increase in its size will distinguish it from a growth of the parenchyma or capsule. When due to nephrectasis, it will only be in the presence of other symptoms suggestive of new growth that we shall be able to exclude the other causes which give rise to hydro- or hæmato-nephrosis.

In the absence of any vesical new growth, the presence in the urine of fragments of villous processes, of a large number of cylindrical or pavement epithelial cells, or of large spherical cells two or three times the size of pus cells and containing highly refractile granules, will indicate the presence of a papilloma of the ureter or renal pelvis, and will serve to exclude a new growth of the capsule or renal parenchyma.

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* *Trans.*, vol. xlix., p. 168.

A cystoscopic examination of the bladder may by a fortunate chance disclose the extremity of a papillary growth projecting from the ureteral orifice, and whether this be a detached fragment or a pedunculated tuft attached to the ureter it will serve to proclaim the cause of the symptoms, though it does not inform us of the exact primary seat of the disease, which may be in the lower end of the ureter, and not at all in the kidney; nor does it tell us whether the nature of the disease is carcinomatous, sarcomatous, or benign. As we have seen, a villous carcinoma in the renal pelvis may be associated with a benign papilloma in the ureter or bladder, and kill the patient by generalisation of the cancer.

Symptoms.—The symptoms of new growths of the renal pelvis are tumour, hæmorrhage, and the characters of the urine. Pain is a very inconstant symptom, is seldom a prominent one, and is not often present except when the renal tumour has attained a great size.

Nephrectasis, whether from distension with urine, or blood, or with a mixture of both, is one of the most frequent of symptoms. It occurs in about two-thirds of the cases. It may be the first symptom, but it is not so frequently so as hæmaturia. In one of the Middlesex Hospital cases it was noticed three months before the hæmaturia. More frequently the hæmaturia is noticed before the tumour. The tumour may be continuous and increase steadily, or may intermit, being sometimes entirely absent while at others it is large, tense, and painful.

Intermittent hydro- or hydro-hæmato-nephrosis depends upon the variation in the degree of obstruction which the growth causes from time to time. When the obstruction is overcome by the weight of the accumulated fluid above or by the shifting of the position of the tufts, or by their shrinking after the subsidence of vascular congestion, or by the detachment of a fragment of the growth, the pent-up fluid—be it urine or urine and blood mixed—flows into the bladder and is soon discharged externally, and the tumour subsides. It is, I believe, rare for pure blood to fill the renal pelvis and subsequently escape in this way. My experience leads me to think that when once blood alone distends the renal cavity it is apt to remain there, and become organised and lead to atrophy of the kidney, unless removed by lumbar nephrotomy. Undoubtedly, a large admixture of blood with urine can be so passed off in an intermittent manner, but it requires the flushing action of the urine to get rid of the blood.

Intermittent nephrectasis—whether the retained fluid is simple urine, or urine and pus, or urine and blood—does not, it must be remembered, depend solely upon new growth in the renal pelvis for its cause. A similar condition results from growths in the ureter, or about the ureteral orifice in the bladder,* as well as from causes altogether unconnected with new growths.

The tumour of the kidney may be caused by the great size of the growth which fills the cavity of the organ, and not be due to nephrectasis from retained urine or blood.

Hæmaturia may be intermittent or continuous; and if intermittent it may or may not be associated with an intermittent renal tumour. The intermittent form, attended with an alternation of subsidence and increase of a renal tumour, is more common with villous papilloma than with any other form of new growth, though it also occurs with villous carcinoma and villous sarcoma.

Hæmaturia is usually the earliest symptom. It varies in amount, and, whilst slight and occurring only at long intervals at and for some time after the onset, it frequently becomes so abundant as to threaten life. Indeed, I have known a strong man die from the hæmorrhage due to the villous tufts which projected into three of the upper calyces from a carcinoma of the renal parenchyma.† Nephrectomy was performed, but only as a forlorn hope, when the patient's life was rapidly ebbing away after seven months of almost continuous hæmorrhage. In this case the bladder at times became filled with long clots, which were casts of the ureter, and which would accumulate and coil up in the bladder like a clump of earth-worms, till they were extruded along the urethra to the external meatus, whence they were withdrawn, like string from a string-box, to the extent of many inches. On the evening before the nephrectomy I was a witness of the truth of this description, for I thus withdrew from the urethra an unbroken clot thirty-eight inches in length. Before performing nephrectomy, I opened the bladder above the pubis for diagnostic purposes, because there had never been any pain whatever along either ureter or in either renal region, and it was uncertain whether the growth was in the bladder or in one of the kidneys. Indeed, as by bimanual examination under an anæsthetic a tumour could be felt in the bladder, it was hoped that the whole of the disease would be found there. When the bladder was opened it was at once seen to be filled with a dark mass, which on removal consisted of forty-two and a half inches of coiled-up elongated clot, attached to a plano-convex clot the size of a dried fig, situated over the right ureteral orifice. On removing this there followed, attached to it, twenty-one inches of elongated recent clot, which was seen to be emerging from the right ureter. When laid out after removal this mass consisted of a cord, of the diameter of a penholder, sixty-three and a half inches in length of unbroken blood-clot, with an enlargement at a part twenty-one inches from one end and forty-two and a half from the other.

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* *See* case by author in *Med.-Chir. Trans.*, vol. lix., p. 227 (1876).

† Specimen in the Middlesex Hospital Museum.

The urine.—The characters of the urine may be little or not at all altered, except for the presence of blood. Albuminuria may have preceded the hæmaturia, and may be present between the attacks.

There may be an entire freedom from crystals or tube casts; or crystals of uric acid, or calcium oxalate, or triple phosphates may be present. The absence of pus is often spoken of as being a sign opposed to calculus but in favour of new growth. It must be pointed out, however, that with renal pelvic new growths the urine may yield a heavy deposit and contain pus in fairly considerable quantity. It was present in both the more recent cases at the Middlesex Hospital.

The most characteristic indication which can be afforded by the urine is one which is frequently not found, though searched for assiduously, and that is fragments of villi or numerous epithelial cells derived from the surface of the growth. Such may come from a growth in the bladder, but if happily they chance to be found in the urine drawn off from the ureter by the ureteral catheter, as occurred to Albarran, then the diagnosis of a new growth is certain, although the precise situation of the growth—kidney or upper or lower end of the ureter—is still a matter of uncertainty. This is of great moment from the point of view of operative treatment. On the other hand, if there be a growth in the bladder involving the lower end of the ureter, there may be a renal tumour due to renal retention without there being any growth in either ureter or kidney.

The quantity of urine may be normal, or diminished, or increased. In Kellock's case the man, who had been a fairly heavy drinker, passed a daily average of over eighty ounces whilst under observation in the hospital. In Murchison's case uræmic symptoms set in a week before death, but previously (except for hæmaturia which commenced fourteen months before death) the urine had been quite healthy, though there had been frequency of micturition. At the autopsy simple villous papillomata occupied both renal pelves and the urinary bladder about its base and around each ureteral orifice; both ureters, though free from new growth, were obstructed by coagula.

Frequency of micturition, when complained of, has usually been due to co-existing growth in the bladder (Murchison) or to the large amount of urine secreted (Kellock). Retention of urine may occur through impaction of clots in the urethra.

Pain is rarely an early symptom, and when complained of is due to the passage along the ureter of coagula, or to the tension of the renal tumour, or to the pressure effects upon surrounding organs. If it is caused at an early stage by the passage of coagula, it is most likely to excite the suspicion of calculus, because the character of the pain will be that of renal colic caused by the passage of a calculus. Pain is also referred to the urethra or glans penis when clots are being passed from the bladder. This was the only cause of pain in the case of profuse hæmorrhage to which I have just referred; but neither during the passage of clot along the ureter nor at any other time had pain been referred to the kidney or along the course of the ureter. The co-existence of a calculus in the renal pelvis may very likely produce pain referred to the kidney, ureter, groin, or thigh.

A feeling of numbness in the opposite leg and pain in the loin and leg of the same side as the disease were complained of in one case (Gould's). A dull aching of a more or less constant character in the loin, and tenderness on manipulation of the kidney, have been remarked where the nephrectasis is a constant condition.

The *general symptoms* are weakness, anæmia, marked pallor, loss of flesh, and in malignant cases possibly secondary nodules of disease. Nausea, vomiting, drowsiness, and other symptoms of uræmia occur when suppression of urine begins.

Prognosis.—The prognosis of cancer of the renal pelvis is as unfavourable as cancer beginning in the renal capsule or parenchyma.

Papillary growths of the renal pelvis which are carcinomatous or sarcomatous in their essential character have the same unfavourable prognosis, and for the same reasons, as malignant disease of the kidney generally.

Villous papilloma, though histologically innocent, is clinically far from being so. It extends over a longer period than a malignant tumour, but in the end is as certainly fatal. It leads to the development of secondary growths in the ureter and bladder by the process of engrafting. It may cause death by hæmorrhage or by the consequences of renal obstruction, and finally the growth may undergo changes and take on the characters of an epithelioma, as in the case reported by Drew.

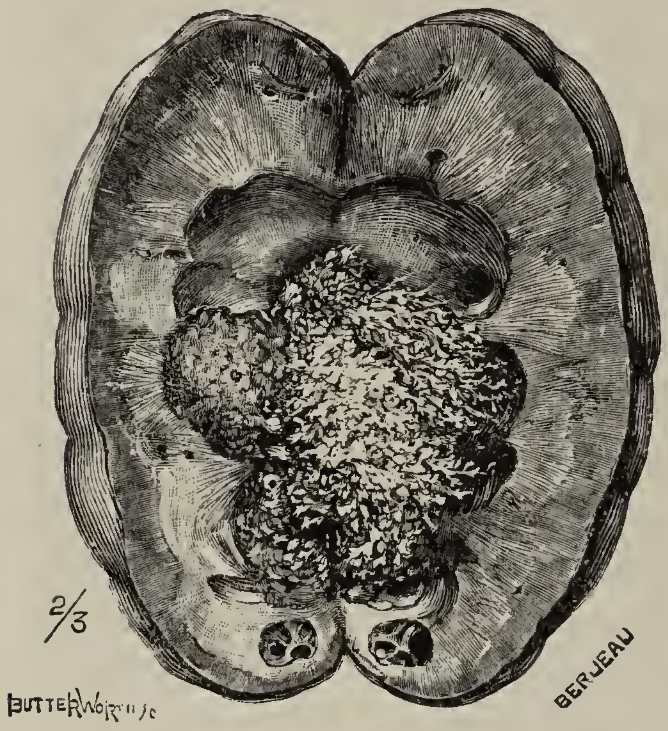

Fig. 107.—Simple Papilloma of Renal Pelvis. (Middlesex Hospital Museum No. 1822A.)

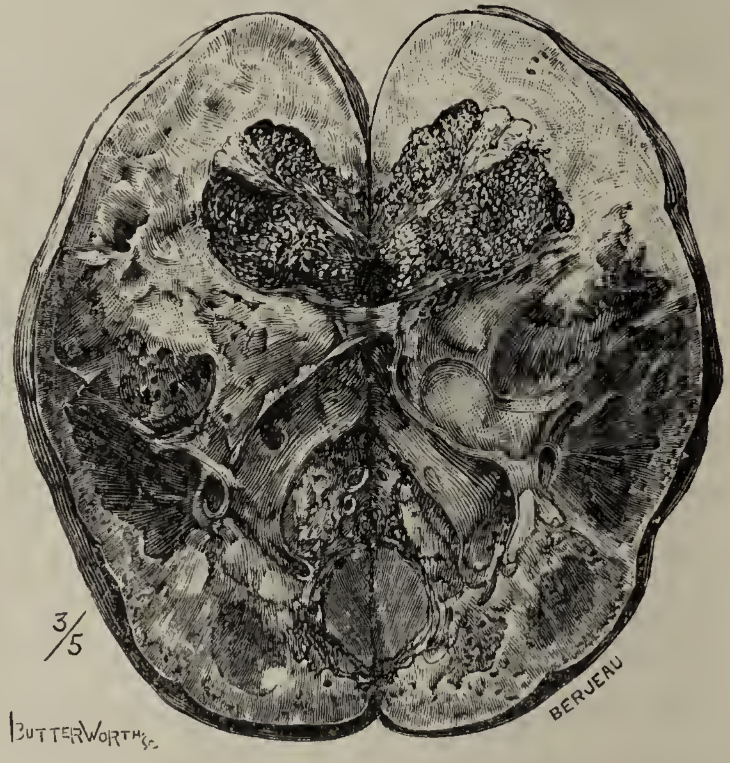

Fig. 107A.—Malignant Papilloma of a Kidney removed by author. (Middlesex Hospital Museum.)

After nephrectomy recurrences may quickly take place,* as in Jones's case, and as in the case of Pantaloni's patient, upon whom primary nephrectomy was performed for a cylindrical-celled epithelioma.

Treatment.—The only hope of curing the patient is by performing nephrectomy in good time. In any case in which the general condition of the patient and the state of the opposite kidney will permit of it, and if there are no indications of metastatic deposits or infiltration of neighbouring organs, the operation ought to be performed as early as possible.

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* *See* an interesting case by H. Fenwick, in the *Transactions* of the Medical Society of London, vol. xx., p. 237.

The very uncertainty of diagnosis between renal calculus, tubercle, various causes of renal distension with or without hæmorrhage, and new growth, is a reason for an explorative operation. One of the dangers most to be feared from a diagnosis based on the X rays as to renal calculus in doubtful cases, is that exploratory examination of the kidney will be put off, and thus an early opportunity of operating in good time upon renal new growths will be lost. It is important that the surgery of the kidney should not be influenced by photography.

Nephrotomy, followed by curetting and the removal of the tumour, as adopted by Battle and Drew, cannot be recommended. Their conservative attempts to save the kidney were very laudable in the absence of positive knowledge of the malignant nature of the neoplasms, but in each case nephrectomy had subsequently to be adopted; nor is it worth while to do anything less in the first place.

If, too, the surgeon bears in mind the impossibility of telling, from the naked-eye appearances, whether a villous growth is benign or has a carcinomatous or sarcomatous basis, he will feel an additional necessity for performing primary nephrectomy. In cases of villous tumours it should be remembered that papillomatous tufts may be diffused far down along the ureter; and for this reason nephro-ureterectomy should be performed, if evidence is found of the diffusion of the growth, or if on catheterising the ureter with a large bougie obstruction is met with in its course. It is possible that the growth may have been engrafted upon the mucous membrane of the ureter just above its vesical end, leaving the rest of the ureter unaffected. When such is the case nothing short of complete ureterectomy, cutting through the ureter close against the bladder, will be of use; and in cases in which the growth has extended to the bladder, the re-section of a portion of that viscus, as well as complete nephro-ureterectomy, may be requisite to obtain a cure, or, the ureter having been removed, the bladder growth should be treated by supra-pubic cystotomy.

As yet the statistics of operations for tumour of the renal pelvis are too few to be of value, but the surgeon's course must be directed by the pathological anatomy of these tumours, and their well-known tendencies to a fatal termination when left to themselves.

CHAPTER XXIII.

PARANEPHRIC OR PERINEPHRIC SOLID TUMOURS.

By paranephric or perinephric * new growths, as defined by some authors, are meant those which take origin from the fibrous capsule or the fibro-fatty investment of the kidney. To these I propose to add a class of tumours probably more frequent, and certainly in many cases much more intimately incorporated with the kidney than those which originate in the fatty tissue around the kidney. I refer to the tumours of the suprarenal capsule, and to those originating in remains of the Wolffian body or in outlying adrenal or renal rests in the cellular tissue around or in the hilum of the kidney.

I propose, therefore, to divide the paranephric tumours into two groups, namely, (1) adrenal tumours, and (2) tumours of the connective tissue type.

Clinically the paranephric tumours so closely resemble true renal tumours as to be scarcely distinguishable from them, and pathologically also it may be difficult to differentiate the one from the other. Many of the paranephric new growths have the kidney simply attached to them; others cause atrophy of the kidney from compression; others spread the kidney, which becomes intimately incorporated with them, over their surface; and others again penetrate the renal capsule or the hilum, and grow into and diffuse themselves in the organ.

Tumours originating in connection with the bowel, pancreas, liver, spleen, or the retro-peritoneal glands are not here included in the class of paranephric tumours, although such may in the process of growth become closely connected with the kidney.

Many tumours, both benign and malignant, which have a retro-peritoneal origin may, after attaining a certain size, become indistinguishable from a true renal new growth.

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* The terms "paranephric" and "perinephric" are here used synonymously. No attempt is made to observe the anatomical difference indicated in Fig. 2, Plate I., Vol. I., Chapter I.

I.—PARANEPHRIC TUMOURS ORIGINATING IN THE SUPRARENAL GLAND OR IN RENAL OR ADRENAL "RESTS."

Pathology.—Much difficulty exists in distinguishing, pathologically as well as clinically, between primary tumours of the suprarenal gland and certain tumours of the kidney, a consequence of which is that tumours of the suprarenal capsule may unknowingly have been removed with the adjacent kidney, and have been grouped with renal tumours.

Primary new growths of the adrenals, especially those which attain to a size large enough to cause an abdominal tumour, are, however, very rare. Roger Williams found only one instance of primary adrenal growth in a collection of 8,378 consecutive cases of malignant disease.

For these reasons less attention has been paid to them by surgeons and in surgical literature than by pathologists. The only account of the adrenals from a surgical point of view which has been attempted since Le Dentu added a few pages at the end of his work on "The Surgical Affections of the Kidney and Ureters," published in 1889, is that recently given by Tuffier. Leconti and Robert have also made valuable contributions.

The nature of the primary enlargements of the suprarenal gland may be either (1) a purely glandular proliferation like simple parenchymatous bronchocele which some pathologists have not very appropriately called "adrenal goitre"; (2) large adenoma; (3) malignant growths which many have described as carcinoma, others as positively as sarcoma.

Routier published in 1894 a case of hæmorrhagic cyst of the central part of the left suprarenal capsule which contained 1,600 grammes of fluid. Deroubaix, Letulle, and Reclus met with similar cysts, according to Cestan. Hydatid cysts of the suprarenal have been noted but are very rare. John Ogle, Rolleston, and Raymond Crawfurd* have recorded cases of cystic disease of the suprarenal gland, due in all probability to softening of adenomatous tumours: the cysts varied in size from a cherry to a walnut.

The origin of certain other paranephric tumours is in adrenal "rests" which are sometimes found in the tissues around the kidney or in the renal hilum.

Retro-peritoneal remains of the Wolffian body in the neighbourhood of the kidney are probably accountable for certain paranephric tumours. Lockwood[*] mentions two cases of retro-peritoneal cysts probably of this origin which came under his observation: one the size of an ostrich's egg, the other as large as a cocoanut, and both filled with albuminous fluid. One was unilocular, the other multilocular. They were removed from a young woman aged twenty and from a middle-aged woman respectively. In each case the cyst lay in front of the ureter, and just below the kidney. In neither case was the exact relation of the tumour diagnosed, but the unilocular cyst was regarded, before operation, as being a hydro-nephrosis of the left kidney.

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* *Path. Soc. Trans.*

Pawlik has recorded a case of retro-peritoneal cyst with serous fluid contents; this also was mistaken for a hydro-nephrosis of the left kidney. It reached from the diaphragm to the iliac fossa, caused a great prominence in the lumbar region, and its surface resembled a multilocular ovarian cyst. It is not improbable that this also was a paranephric tumour derived from the remains of the Wolffian body.

The Wolffian body extends along the ureter between the liver end of the suprarenal capsule and the ovary or epididymis. It is not known how long this portion of the body persists or what ultimately becomes of it, but it would seem highly probable that it occasionally gives rise to certain retro-peritoneal cysts—judging by the proneness of the part of the Wolffian body which is in relation with the ovary or testis to do so. A growth originating in the perinephric tissue or in the adrenal may invade a large cyst of the kidney and spread in its walls without invading the kidney itself. I have published such a case,[†] and Fig. 86 (Vol. I., p. 562) illustrates the involved renal cyst.

It is unsettled as yet whether the suprarenal capsule is developed from the front part of the Wolffian body or not, but the observations of Weldon, Janosik, Lockwood, and others prove conclusively that the two are continuous even to a somewhat late period of intra-uterine life. Lockwood[‡] has pointed out that at about the seventh week the suprarenal capsule in the human embryo—which is larger than the kidney itself, and lies above it—extends by its lower end downwards in front and to the inner side of the kidney, occupies the hilum of the kidney, and is continuous along the course of the ureter with the upper end of the Wolffian body. He also shows that the glomeruli of the Wolffian body are continued some distance into the lower end of the suprarenal body.

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[*] *Journ. Anat. and Physiology*, vol. xxxiv., p. 83.

[†] *Brit. Med. Journ.*, Nov 11, 1899, p. 1337.

[‡] Lockwood, "Hunterian Lectures on the Development and Transition of the Testis," 1887; also *Path. Soc. Trans.*, vol. xlix.

Rolleston has shown that even in an adult the suprarenal capsule is often prolonged into the renal hilum, and that supernumerary suprarenal bodies may extend lower down still; and Andrewes has found small adrenals in some fatty tumours of the spermatic cord.

It is now well known that bodies identical in structure with the suprarenal gland are found not only in the cortex of the kidney, but also in the perinephric tissue, in the mesentery, beneath the capsule of the liver (Schmorl), in the broad ligaments of a fœtal uterus (Marchand and Targett), and in the inguinal canal; but outlying adrenal rests in these distant situations are very rare, and are seldom observed by those constantly engaged in post-mortem examinations. Bayard Holmes,* however, states that remnants of the adrenal body are found in various parts of the genito-urinary tract in 90 per cent. of all post-mortem examinations.

Albarran is of opinion that many tumours arise from aberrant renal lobules embedded in the capsule of the kidney and capable of degenerating into epithelioma. Collections of embryonic tubes have been discovered in the renal capsules of a great number of fœtuses, and probably they represent aberrant formations derived from branchings of the convoluted tubules of the cortex which have not come into relationship with the glomeruli of the renal parenchyma.

The microscopical characters of the same tumour † are capable of various interpretations. What one regards as a typical renal tumour of accessory adrenal origin another speaks of as a spheroidal-celled carcinoma, another as an endothelioma, another as an epithelioma with clear cells, another as a renal adenoma, and again other observers have described them as primary angeiosarcoma, or alveolar sarcoma, or lymphadenoma.

Kelynack probably gives the true explanation of this when he says: "Although these growths may for convenience be placed in the large class of adenomatous forms of renal growth, it is clearly to be remembered that the cells of the suprarenal, although morphologically epithelial, are strictly of mesoblastic origin, and growths arising in adrenal 'rests' appear to be sarcomatous in general characters rather than carcinomatous."

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* *Journ. of the Amer. Med. Assoc.*, July–Dec., 1898, p. 405.

† *See* an excellent account of kidney tumours derived from suprarenal "rests," by Dr. McWeeney, of Dublin, *Brit. Med. Journ.*, Feb. 8, 1896, p. 323.

Unless it can be shown that there is a distinct difference in the manner in which the kidney is encroached upon by a primary adrenal or other kind of paranephric growth, as distinct from a renal new growth originating from an adrenal "rest" within the kidney or from the renal tubules themselves, or unless in any given case it is found that the suprarenal gland on the same side as the tumour is unaltered, it will not be possible in all cases to distinguish, even after their removal from the body, the one class of tumours from the other.

In several instances the same tumour has been regarded by different microscopists and pathologists of equal experience and skill as a pararenal tumour primarily of the suprarenal capsule, and as a renal tumour contained entirely within the fibrous capsule of the kidney; and the confusion reaches its height when a tumour is described as a primary tumour of the suprarenal gland, and yet is stated to have "the capsule of the kidney continued over the surface of the tumour," as in the account of the specimen removed by Mr. Knowsley Thornton, and now in the Hunterian Collection, No. 3597.* Differences of opinion are entertained not only as to the pathogenesis of tumours, but also as to the manner in which a malignant tumour originating in the suprarenal gland or in the perinephric tissue may come as it grows to involve the kidney. Does it invade the kidney and cause its destruction; or does it merely flatten the adjacent part of the kidney as a simple mechanical effect of pressure whilst the two organs remain definitely separated by the fibrous capsule of the kidney? It is probable that it may do either.

The relations, or apparent relations, of the capsule to the various tumours in and around the kidney are not reliable as a guide to their morbid anatomy. The isolation from the renal parenchyma of a tumour situated immediately beneath the renal capsule is far from being decisive in favour of Grawitz's theory; neither is the argument that the capsule of the kidney seems to be continued over the tumour a decisive proof that the tumour originated in the kidney, and not outside it.

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* "Harveian Lectures," 1889, pp. 75–6.

A primary tumour of the suprarenal gland, like an encapsuled renal tumour, may stretch the kidney substance like a hood over part of its surface; and as the tumour increases in size, the stretching of its own capsule, the thinning by compression of the capsule of the kidney, and the addition of a certain amount of connecting fibrous tissue may give it an appearance indistinguishable from that presented by a renal growth springing from an embedded accessory adrenal. Such newly formed fibrous tissue is seen as a band in Fig. 77 (Vol. I., p. 540). In other cases it might develop into a more or less complete capsule. Again, as a tumour developing from an adrenal " rest " grows, little gaps may form in the capsule on its deep aspect, and little offshoots of the tissue may spread into the parenchyma of the kidney, whilst a few convoluted tubes may be seen on section in the tumour itself. There is equal reason to believe that as a primary adrenal grows downwards it may invade and cause the destruction of the kidney tissue, just as in Affleck's case a tumour, primarily of the right kidney, was found to have grown upwards and invaded and destroyed part of the liver.

It would also seem that incomplete development of the capsules of the kidney and suprarenal gland may allow of mutual interpenetration of part of each organ into the other. In one of these ways could be reconciled a description such as that given by Eve and Targett of Thornton's case, and which otherwise appears irreconcilable—namely, that the renal capsule was continued over what was considered to be a primary tumour of the suprarenal gland. Ricker has described a case in which the kidney and suprarenal gland were thus firmly united, the tissue of each extending into the other.

There is another condition which may account for the same appearance. In a case recorded by Eurich a nearly spherical tumour having adrenal structure was found in a space between the apparently normal suprarenal gland and a very small ill-developed kidney. This tumour had not encroached upon either suprarenal gland or kidney, either by invasion or compression, but had, so to speak, merely served to " fill a gap." The fibrous capsule of the suprarenal gland, however, " was prolonged at the lower pole of the tumour to form a short but broad pedicle, by which it was continuous with the capsule of the kidney." *

Symptoms.—No wonder, when the anatomical and microscopical characters are insufficient to distinguish a circumrenal from a renal new growth—a primary adrenal from a primary renal tumour of accessory renal origin—that little or nothing which is distinctive can be stated as to the symptomatology of adrenal tumours. In fact, the diagnosis in some cases is not only difficult, it is impossible; and this is not surprising considering the proximity of the two organs, the similarity of their position behind the peritoneum, the not unfrequent absence of hæmaturia in renal tumours (50 per cent.), and its occasional presence in primary adrenal tumours. Hence it has happened that the cases recorded in Otto Ramsay's paper of "Excision of Primary Tumours of the Suprarenal Gland," Knowsley Thornton's case, Ward's case, published in the *British Medical Journal* on October 21st by Mayo Robson, and the three cases reported by me,* were all diagnosed and operated upon as renal tumours.

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* Kelynack, p. 143.

The symptoms given by Ramsay from an analysis of thirty-seven out of a total of sixty-seven cases, in which the reports were full enough for the purpose, were the following:—

1. The most frequent symptom, seen in twenty-two patients, was a marked and steadily increasing loss of strength, accompanied in many cases by extreme languor and debility.

2. Emaciation, varying greatly in degree, was noted in twenty cases: in few only of these was the loss of flesh extremely marked.

3. Gastro-intestinal symptoms were the next most frequent. Twelve out of thirty-seven complained of nausea and vomiting, nine of loss of appetite, five of constipation, and four of diarrhœa.

4. Pain in different parts of the body was complained of in twenty-five cases. The pain was referred variously in different cases to the renal region, to the whole length of the back, to the epigastrium, one or the other of the hypochondriac regions, or to the knee or ankle-joints. In several there was tenderness on pressure in the epigastrium or over the tumour. The pain was generally intermittent, but in some continuous. Mayo Robson lays stress on *shoulder tip pain,* which was noticed in three cases, and explains it by the fact that small branches of the phrenic nerve join the semilunar ganglia.

5. The circulatory system in adrenal tumour, as compared with Addison's disease, was rarely involved; palpitation or anæmia was a symptom in eleven cases, and œdema of the legs in six. In most cases the œdema was due to renal

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* *British Medical Journal* of Nov. 11, 1899, p. 1336.

changes, and not to the tumour; and it is a remarkable fact that in four or five cases in which there were extension of the growth into the vena cava and thrombosis the patients had no œdema.

6. The skin changes were not marked, only three out of the thirty-seven showed distinct bronzing; but in nine there was some change in the colour or texture of the skin, which was described as a "brownish discoloration," "muddy looking," or "of a yellowish colour." In two there was a peculiar profuse growth of hair. Both of these cases (Cayley's and Fox's) were in young children. Other writers, however, describe the same symptom in adults also. A marked cretinoid appearance, with abundant growth of hair over the whole or greater part of the body, has been described by Fox and Ogle in children with adrenal sarcoma. Targett, in an adult female, the subject of primary sarcoma of the suprarenal body, met with hypertrichosis. In a female, aged thirty-six, from whom Thornton removed a tumour, which Targett and Eve examined and considered a tumour of the suprarenal gland, the whole body, including the chin and upper lip, was thickly covered with long, dark, soft hair. This grew so rapidly that, though the abdomen was shaved for the operation, the hair quickly reappeared, and was a source of much trouble during the after-treatment of the wound.

7. Hæmaturia was noticed twice, and, as Ramsay remarks, this is important, because it makes the differential diagnosis between renal and suprarenal tumours still more difficult. In both of these cases, however, it should be noticed that the hæmorrhage was really due to associated renal conditions—a cauliflower growth in the renal pelvis in one, and cystic changes in the kidney in the other.

8. An abdominal tumour was noted in a good many cases, but how often during life, as distinct from post-mortem discoveries, could not be deduced from the reports.

9. In thirteen cases out of the sixty-seven the new growth in the suprarenal capsule caused no symptoms whatever referrible to that body. In five of these the symptoms were entirely confined to the respiratory tract: pneumonia, gangrene of the lung, extensive metastatic growths in the lung (two cases), and intense bronchitis and weakness were the causes of death in these five cases.

There is an absence of hepatic and gall-bladder symptoms. As a rule, in adrenal growths there is an absence of any marked urinary symptoms, but if the growth spreads through its capsule (like some of the aberrant adrenals spread through gaps in the deep aspect of their capsules) and invades the kidney, the urine may present the same changes as primary renal tumours are known to do.

The adrenal tumour may displace the kidney either downwards or outwards, and the kidney may give rise to a distinct prominence upon some part of the surface of the tumour, as it did in Fig. 76 (Vol. I., p. 535). In Fig. 77 (Vol. I., p. 540) the kidney, much altered and mis-shapen, was pushed below the tumour.

In a case recorded by Cohn a distinct transverse groove marked the junction between the tumour and the kidney. In one of Thornton's cases the kidney lay in a cleft of the tumour, and in the other it was pushed down almost into the iliac fossa, and was mistaken for a lobule of new growth. In one of Kelly's cases (reported by Ramsay) there was a kidney-shaped prominence on the surface of the tumour. Pawlik has noted this feature in the tumour as an aid to diagnosis, but even where it is present it is very difficult to be sure that the prominence is due to the kidney and not to a projecting lobule of the tumour.

Extreme mobility of the tumour will, I believe, be found to be in some instances a notable symptom; it was so in two of my own cases. When the patient sat up or turned to one side it fell downwards, forwards, or inwards, by its own weight, moving more freely than a very movable kidney. This makes the enucleation of the tumour so easy in certain cases, and is doubtless due to the large quantity of loose areolar tissue which surrounds it, and to its early subjection to movements of the diaphragm. In other cases, if the growth becomes adherent to the diaphragm, liver, or spleen, it will not have this character, but, on the contrary, may become dangerously fixed.

The rapidity of growth and the greater frequency of metastases would seem to be in favour of adrenal as opposed to renal new growths. Rapidity of growth was a marked feature of one of my own cases. The numerous metastases which occurred in another case (Fig, 108) are of special interest as bringing adrenal tumours into strong resemblance with the remarkable case which I reported to the Pathological Society in 1880* of "general thyroidal malignancy" in which multiple tumours with the microscopic characters of thyroid gland tissue occurred in the bones of the skull and of the extremities and in the viscera, as secondary to enlargement of the thyroid gland.

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* *Trans.*, vol. xxxi., p. 259.

There is a tendency for adrenal tumours to invade the diaphragm and spread into the chest. This, there is no doubt, occurred in Case 3, published by me in the *British Medical Journal,* November 11th, 1899.

Varicocele on the side of the tumour was present in one of my cases, and I have already referred to varicocele as an occasional symptom in renal tumours on p. 582 of Vol. I. The varicocele comes on possibly before the appearance of a tumour, increases with the tumour, and rapidly disappears after removal of the tumour.

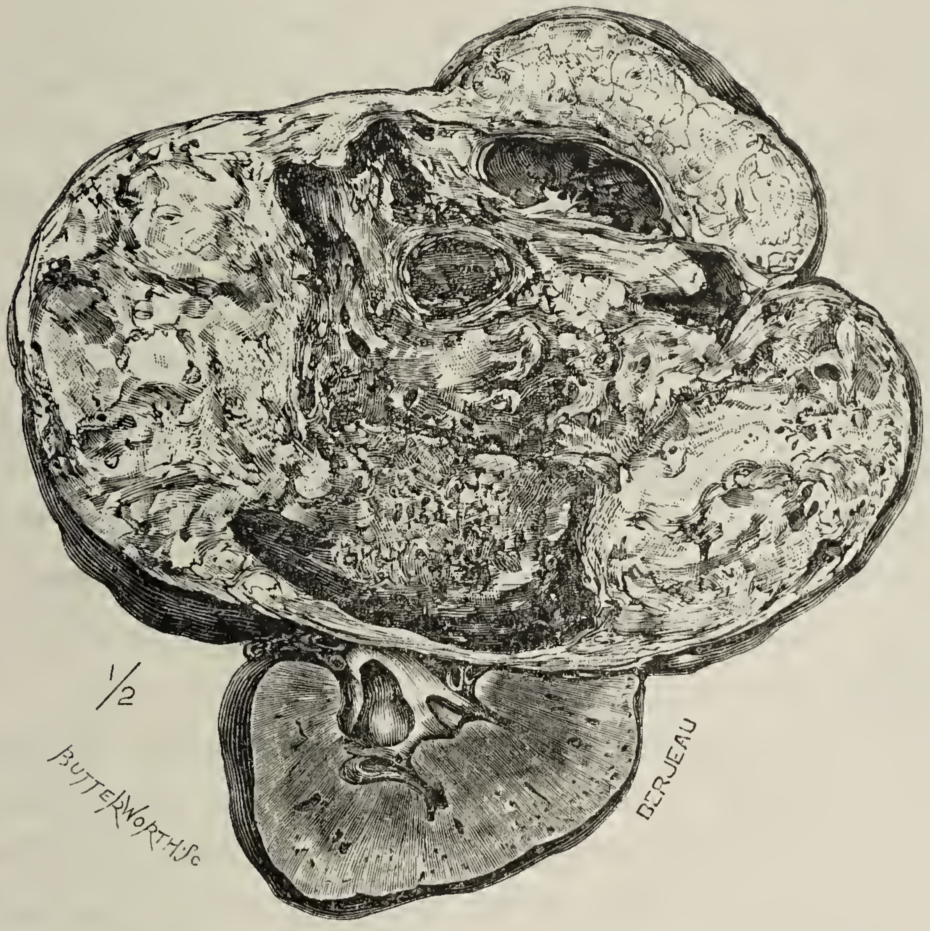

Fig. 108.—Transverse section of Right Kidney and Adrenal Tumour, the same Kidney as in Fig. 77 (Vol. I., p. 540). There were numerous secondary deposits in the liver, skin, and subcutaneous tissues, and in the left temporal region. (Hunterian Museum, No. 3584 F.).

Roger Williams found that of thirty-six collected cases of malignant tumours of the suprarenal gland, more than one-third occurred in infancy and childhood, some being even met with at birth. It has been thought that in children, primary adrenal tumours are less frequently bilateral than primary renal new growths, but this point is not satisfactorily established.

Diagnosis.—Granted that in any given case there is the following group of symptoms, the diagnosis of a primary adrenal new growth should be made, and will most probably be correct.

1. A tumour in the suprarenal or renal region with a kidney-shaped prominence on its surface.

2. An unusual degree of mobility of the tumour, so that it falls away from the loin on the patient rising or turning on to the opposite side.

3. Rapidity of growth of the tumour, and secondary growths in the skin, liver, or the temporal region.

4. Marked emaciation and rapid loss of strength.

5. Absence of any change in the urine, and of any alteration of the normal temperature.

6. The presence of some pigmentation of the skin, or of marked or rapid growth of hair over the body.

7. Some gastro-intestinal symptom, such as nausea, vomiting, diarrhœa, or constipation.

8. Pain, deep seated, in some part of the abdomen; or an ill-defined, unexplained pain in some joint or distant part of the body.

It is, however, the exception to find the whole or even the majority of these symptoms present in any given case. If several of them are absent, and especially if there is no tumour, a positive diagnosis is quite impossible.

Tumours of the suprarenal gland might have to be diagnosed from other conditions of that organ, such as tuberculosis and blood cysts. Tuberculosis rarely gives rise to a palpable tumour; besides, the general state of the health, the temperature, and the presence of tubercle in some other organ or part of the body would assist the diagnosis. A. F. Jonas published a case of a patient who had a palpable tumour due to tuberculous disease with symptoms pointing to a suprarenal new growth. He performed an exploratory operation and successfully removed the suprarenal mass.

Blood cysts of the suprarenal gland are rare. Drouboix and Ramsay have studied them. They seem to be due to a necrosis and a subsequent hæmorrhage into the centre of a new growth, usually an adenoma. The cyst wall may be thickened, but otherwise is normal and composed of unchanged suprarenal tissue. The symptoms in some of the cases have been exactly like those of a malignant adrenal tumour, and a differential diagnosis has been quite impossible.

The difficulty of diagnosis is evident from the fact that in all the recorded cases of operation—except two, which were mistaken for hepatic or gall-bladder tumours—as well as in many cases not submitted to operation, the growths were taken to be renal tumours. It is more than doubtful if even a close attention to Piorry's description of the adrenal dulness, or special experience in the use of the phonendoscope of Bianchi, would enable us to distinguish the renal from the adrenal new growths. Early or profuse intermittent hæmaturia, with a tumour in the renal region and pain taking the course of the ureter, would point very strongly indeed to renal in distinction to suprarenal new growth. The absence of all symptoms referrible to the urinary organs is the rule in primary adrenal tumours, but we must bear in mind the exceptions as regards hæmaturia. It is well to remember also that though hæmaturia occurs as the earliest symptom in 41 per cent. of malignant tumours in the adult, it is observed in only 5 per cent. of malignant renal tumours in children under five years of age (Heresco).

Tumours of the suprarenal gland have also been mistaken for enlargements or tumour of the liver. In some instances the liver has been actually enlarged.* In Cohn's case † the liver was thought to be considerably enlarged, but at the necropsy it was found to be normal in size but displaced downwards by the adrenal tumour. The absence of jaundice, the characters of the enlargement, the presence of resonance in front of the tumour, and extreme mobility instead of a comparative fixation of the swelling would tend to exclude the liver. As Ramsay remarks, "careful consideration of the symptoms, and a painstaking physical examination would, in most cases at least, serve to distinguish the two."

Between tumours of the adrenal and enlargement of the gall-bladder mistakes in diagnosis ought seldom to occur. If an adrenal growth is seen before it has attained too great a size to simulate the gall-bladder in position or form it will be found presenting below the costal margin, more to the right and more posteriorly than the gall-bladder does, and there will probably be resonance in front of it. Movable—and possibly extensively movable—it is not pivoted beneath the liver as an enlarged gall-bladder is. An enlarged gall-bladder, being so pivoted, moves mostly towards the median line and in the arc of a circle whose centre is beneath the notch of the liver.

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* *See* Case 2 in article by the author, *Brit. Med. Journ.*, 1899, vol. ii., p. 133 and Fig. 108.

† *Berl. Klin. Woch.*, 1894, No. 11.

With the fingers dipped below the free border of the liver the tumour will be felt behind it, and by pressure can be made to recede backwards and upwards from it. There will also be an entire absence of any history or symptom suggestive of biliary colic. Further, great depression, weakness, and emaciation, in the absence of jaundice, would also incline one to think of new growth of the adrenal. Lastly, should it be impossible to exclude hepatic or cystic disease, the diagnosis will be cleared up by an abdominal exploration through the linea semilunaris, an incision along which is the one best suited for the removal of adrenal growths.

A pancreatic cyst may closely simulate an adrenal tumour in general symptoms—emaciation, weakness, nausea, vomiting, and epigastric discomfort or pain—but the position in which the tumour first appears, and its mode of increase, are very different in the two cases.

Prognosis.—The prognosis of adrenal tumours is very unfavourable owing to the rapidity of growth, the tendency to metastases, and the frequency with which both glands are affected. The immediate risk of an operation when any portion of the tumour is left behind is very great, and if the patient recovers recurrence follows with terrible rapidity.

The prognosis is more serious even than in malignant renal tumours. Whereas the average duration of life in sarcoma of the kidney is five to six years, and of carcinoma three to four years,* Otto Ramsay points out that the average duration from the onset of the first symptom to death was from 6·7 to 10·6 months, the shortest duration being six weeks and the longest thirty-six months. The mortality of operation for tumours of adrenal origin is a little higher, and the prognosis after a successful operation is about the same as after nephrectomy for malignant renal tumours.

Robson gave a table of eight cases in which operation had been performed, of which four recovered and four died. Adding my own three cases of removal of adrenal tumours, two of which recovered from the immediate effect of the operation, we have eleven cases, with six recoveries and five deaths. Of my two cases which recovered from the operation one died about ten months and the other within six months after the operation. One of Robson's cases died "a few months" after the operation from recurrence. The other case, in which the tumour with only a portion, not the whole, of the kidney was removed, was alive and well between eighteen months and two years after the operation.

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* These figures as given by foreign writers are much more favourable than those quoted by Kelynack from various English authors.

Heresco, amongst 165 cases of nephrectomy for malignant disease, performed between 1890–98, found seventeen cases of operations for tumours described as "struma-suprarenalis." How many of these seventeen were primary adrenal tumours and how many renal tumours arising from embedded adrenal "rests" is not clear.

The following figures taken from this collection show the immediate and remote effects of nephrectomy for the different classes of renal tumours: sixty-eight sarcoma of all forms, fourteen died—that is, 20 per cent.; fifty-three carcinoma of all kinds, twelve died—that is, 22·56 per cent.; fourteen adenoma, all successful; seventeen struma-suprarenalis, five died—that is, 29·4 per cent.

Of the patients alive two years after nephrectomy, and still free from recurrence, the percentages were: 25·9 for sarcoma, 25 for struma-suprarenalis, 9·7 for carcinoma.

Of the survivors after nephrectomy who had recurrence within one year there were 33 per cent. of the sarcoma, 25 per cent. of the struma-suprarenalis, and 9·7 per cent. of the carcinoma.

Treatment.—Operation gives the only hope of life. It should be done as early as possible, because the probability of metastases, and of adhesions forming which will make the operation difficult, increases as time goes on. It should be undertaken by way of an exploratory operation, and removal should not be attempted unless it can be completely effected. When the tumour is adherent to the liver or spleen, the risk of hæmorrhage proving fatal is very formidable; when adherent to the diaphragm the pleural cavity or pericardium might be opened. When metastases are found in the viscera, it is only with the view of relieving intense suffering that removal should be effected, and then only when the tumour is very freely movable, so that its enucleation can be accomplished without risk or difficulty.

The method of operation should in some cases be the transperitoneal by an incision through the linea semilunaris, in others the lumbar, and in others again the combined lumbar and trans-peritoneal method, which I have for many years adopted in cases of nephrectomy when the kidney is much enlarged.

1. If the tumour is large and very freely movable, the trans-peritoneal route answers best. The incision in the linea semilunaris may be joined if requisite by a short one at right angles to it, carried either forwards or backwards, as best suits the individual case.

2. When the tumour is situated well back in the loin, and is cystic or not very large, the lumbar method is to be preferred. If the space between the last rib and the crest of the ilium is contracted, the last rib, or even the last two ribs, should be excised, and the lumbar incision carried freely forwards. When this space is roomy, the ordinary oblique incision amply suffices for the enucleation and delivery of a tumour of moderate size, or one which is diminished by tapping.

3. When the diagnosis is uncertain or the tumour is large and fixed, or but slightly movable, the exploration should be first made through the incision along the linea semilunaris. Before, however, any attempt at enucleation is begun in front, an oblique lumbar incision of moderate length should be made, and through this all the posterior outer, upper, and lower connections should be severed. This wound should then be plugged with a sponge or with gauze, and the enucleation completed and the vessels ligatured from the front. The delivery of the tumour through the anterior wound is very greatly facilitated by the fingers of one hand in the posterior wound.

There are many advantages in the combined method in cases of large and adherent tumours which I will not dwell upon here, but will merely strongly recommend it to surgeons who have not tried it.

Ramsay says if the tumour is excised it is wise to remove the corresponding kidney, because of the frequency of metastases; but I cannot accept this judgment as decisive. On the contrary, if after close inspection and careful palpation it is found unaffected, the kidney ought not in my opinion to be removed. In some cases partial nephrectomy has been performed, as in Robson's second case. Partial nephrectomy has been practised in some five or six cases of malignant tumour of the kidney itself, but the surgeons were all under the impression that the new growths were benign. In three of these cases, however, the patients were well several months after the operation, one died of hæmorrhage, and one subsequently underwent total nephrectomy for recurrence of the disease, and died five months later.

The friability of the tumour and the great hæmorrhage which occurs when its texture becomes broken into are the chief risks attached to the operation. Should the tumour have grown into the spleen or liver, as in Affleck's case, and an attempt is made to detach it, the loss of blood would probably be fatal.

II.—PARANEPHRIC TUMOURS OF CONNECTIVE TISSUE TYPE.

These are very various, and the same tumour often varies in structure in different parts. Thus we find lipoma, fibroma, myxoma, sarcoma, and mixed forms of tumour. Pure myxoma is very rare. Lotheissen, however, has reported such a case (1896) where the tumour was independent of the kidney and was situated between it and the suprarenal capsule. Myxo-sarcoma is more frequent.

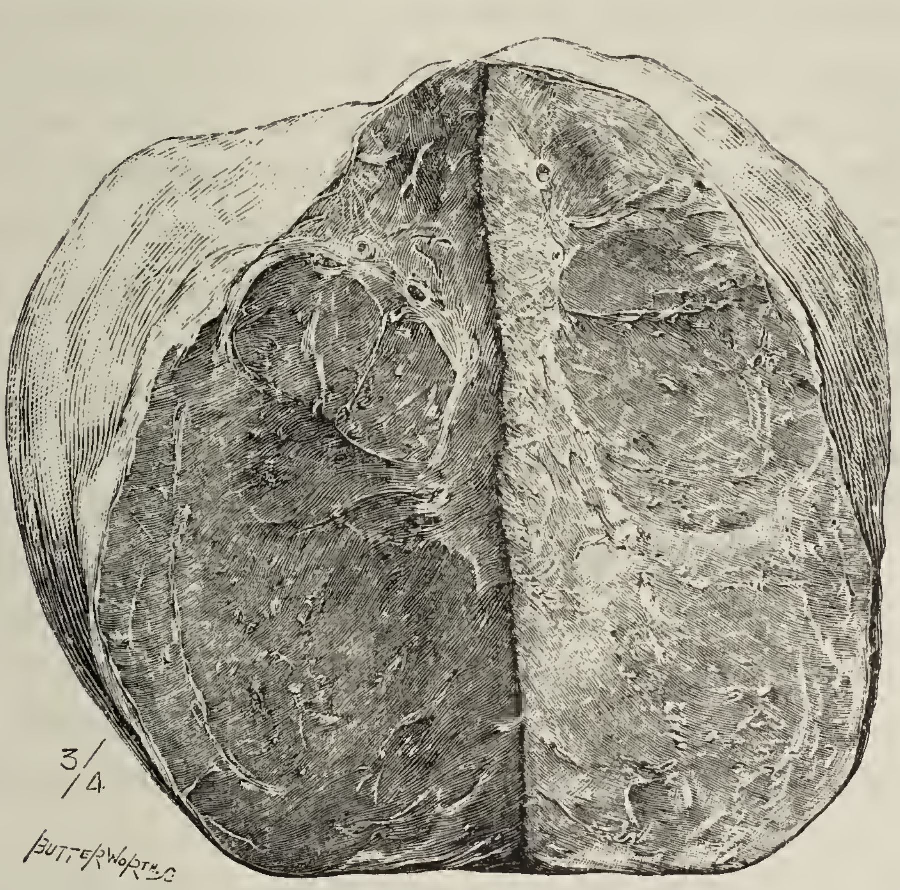

Fig. 109.—Retro-peritoneal Fibro-lipoma removed with the Kidney from a lady aged 70. (Author's case.)

The mixed tumours are fibro-lipoma, fibro-chondro-osteo-lipoma, myxo-lipoma or lipoma myxomatodes, and lympho-sarcoma.

The most frequent forms probably are fibro-lipoma (Thiriar, Spencer Wells, Laurenhaus, Monod, Eiselsberg) and lipoma-myxomatodes or myxo-lipoma.

Cases of retro-peritoneal lipomata are far from being all circumrenal. They sometimes commence in the mesentery, especially in the mesocolon or in the iliac fossa or within the true pelvis, but it is probably not far wrong to say that about one-third have a perinephric origin. Salzer of Vienna and Adami of Montreal have drawn special attention to the perinephric development of these growths.

It would lead to unnecessary repetition to describe separately the several varieties of tumours enumerated above. Moreover, it would be to a certain extent impossible; because every form of tissue, fibrous connective tissue, pure lipomatous tissue, and lipomatous tissue, mixed with mucin, cartilage, bone or sarcomatous tissue may be all blended in the same large tumour. A general description will be given of the whole group, but as the lipomata are much the least rare, most of the statements are based upon the published records of this particular variety.

Etiology.—It should be premised that in speaking of paranephric lipomata, distinct neoplasms of fatty tissue are meant, which primarily at least, if at all, do not invade the tissue of the kidney: not those great overgrowths (which occur in connection with renal calculus and other forms of chronic renal disease, especially of atrophic forms) of fatty or fibro-fatty tissue around the kidney which extend into the hilum and in rare cases are associated with the conversion of the renal substance into fatty tissue. (Compare Fig. 109 with Fig. 117, p. 73 *post*, and Fig. 34, p. 272 of Vol. I., in illustration of the difference between a perinephric lipoma, a kidney transformed into fat, and a kidney surrounded by lipomatous perinephritis.)

In calculous pyo-nephrosis, renal tuberculous abscesses, tuberculous pyo-nephrosis, and in atrophy from different causes, the abundant circumrenal fat which exists normally is prone to increase greatly—a fact which has been referred to in other chapters of this work.

But what are now to be referred to are "tumours"—whether of fat, fibrous, myxomatous, or sarcomatous tissue—whether circumscribed or diffuse, encapsuled or non-encapsuled, which have a more or less intimate connection with the kidney, whilst the kidney itself, which may be more or less embedded in the new growth, or flattened or displaced, is rarely infiltrated by it except in the case of paranephric sarcoma.

The sarcomata and the mixed tumours are met with perhaps oftener in young persons; the fibromata and lipomata are certainly more frequent in adults. The mixed tumours and sarcomata are occasionally met with in quite young children.

Roger Williams mentions the case of a male child aged two in whom the left kidney was surrounded by a mass of soft, ecchymosed, myxo-sarcomatous new growth.

The lipomata are most common in adult life between the ages of thirty and fifty, though a perinephric lipoma has been observed in a child of three, and several times in persons between sixty and seventy years of age. They affect either kidney indifferently. Spencer Wells had a case in which there was a tumour on each side. They occur in temperate, hard-working persons of good health. Females seem to be more frequently affected than males, according to Maukiewicz and Galimir, in the proportion of sixteen females to six males; according to Adami, in the proportion of twenty-five to sixteen. A great number of cases have been recorded in France, but England, Germany, and Scandinavia have each supplied to literature nearly as many as France. Others have been reported from America, Switzerland, Austria, and Belgium.

Pathology.—When the tumour surrounds the right kidney the liver may be pressed upwards and its vertical measurement diminished; when on the left side the spleen may be partially embedded in the growth.

The connection with the kidney may be very intimate; the kidney may be closely adherent to the tumour, or one or the other end of it may be atrophied or flattened, or it may be displaced by or embedded in the growth. In Wigglesworth's case of a woman aged forty-three, the right kidney was embedded to the depth of one inch and a half in the tumour. The tumour, a myxo-lipoma, had no pedicle, but had formed very thick and tough adhesions, especially towards the pelvis. It weighed forty-one and a half pounds, had greatly compressed the anterior margin of the liver, produced œdema of both lungs, and led to death by dyspnœa. In a case under my care the left kidney was displaced downwards and carried forwards in the mass of the tumour, and occupied a position over the front of the left sacro-iliac joint.

The tumour may infiltrate the kidney and substitute itself for the renal parenchyma (Monod), but this is quite the exception. The ureter may pass behind or in front of the tumour, and will be pervious.

The growth as stated above may be circumscribed or diffuse; if encapsuled and circumscribed, several encapsuled masses may be so closely welded together as to resemble one multi-lobulated mass. There may be other separate retro-peritoneal growths more or less distinct from the paranephric tumour, either of the same nature or not of the same nature with it. The size attained by the lipomatous tumours may be enormous. From twenty to forty pounds and more has been recorded as the weight of some of them. As they are sometimes fluctuating and but slightly lobulated it is not difficult to understand how they have sometimes been confounded with ovarian cystomata or echinococcus cysts.

The relation of the ascending or descending colon and of the small intestine to these paranephric tumours is the same as in the case of true renal new growths (*see* Vol. I., p. 531).

The intestine may become very adherent to the tumour, as in a case seen by Eiselsberg. Its connection with the tumour may be such that several inches or even some feet of bowel may have to be resected to get away the tumour, as in cases reported by Alsberg, Madelung, Lundin, and Roux.

The ascending or descending colon crosses more or less over the front, as a growth developing evenly around the kidney pushes the colon forward; but if the mass is irregular in outline, and especially if lobulated, the colon may be pushed to one side, or the transverse colon may come to be in front of the tumour.

When the tumour is composed of several distinct lobes, some of them may be separate, and even freely movable, upon the main mass.

The *myxomata* may take the form of a large cyst containing many ounces of gelatinous material or mucoid blood-stained fluid. Such was the nature of a case under treatment in the Middlesex Hospital in 1888.* A man, aged thirty, had a swelling the size of a Tangierine orange below the umbilicus. It rapidly increased, caused pain in the back shooting down to the testicle, and frequency of micturition. The tumour moved with respiration, and when under observation was apparently connected with the liver. It was removed by Mr. Gould, together with the right kidney, by an extra-peritoneal operation, the incision of the abdominal parietes being along the linea semilunaris.

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* *Lancet*, Sept. 15th, 1888, p. 518.

Many of the *lipomata* are composed of pure typical fatty tissue, which in some places may be undergoing mucoid degeneration; in others the fat may have wholly disappeared, and characteristic myxomatous cells are present. According to Adami, this myxomatous change is not found near the surface where the growth appears to be advancing; and the inference is, he thinks, that the mucoid state is not the primary condition as Wigglesworth stated, but a later and degenerative change. From their tendency to undergo mucoid degeneration the name lipoma myxomatodes has been given to these tumours.

Well-marked connective or fibrous tissue separates the fatty lobes, and at the same time covers and unites them. There may be several layers of fibrous tissue covering the tumour. The lobes may vary in size, from a man's fist to an adult's head. One or several distinct encapsuled tumours of simple fat may be connected with the surface of the main mass by connective tissue, or may be separate, and some distance apart from it.

In some cases a spindle-celled growth replaces typical connective or fibrous tissue, and thus a sarcomatous appearance is presented by such portions of the tumour.

Portions of the growth may suppurate and form a large cavity full of greyish-green pus, with ragged and extensively broken-down walls of a similar colour, and here and there thrombosed vessels and patches of old hæmorrhage undergoing colour changes.

In a case reported by Adami of a man aged forty-five, who was only ill one year, sixty pints of pus were drawn off by repeated aspiration during the last four months of the patient's life, and after death three pints more were removed.

The microscopical appearances of some of the growths vary somewhat, so that divergent descriptions are sometimes given of the same tumour. But, as Adami remarks, these divergences are "easily reconciled when we recollect that every member of the group of connective tissue tumours may pass into or show areas of conversion into other members of the group. Tumours, mainly fatty, may show more or less extensive conversion into fibroid, cartilaginous, osteoid, mucoid, or embryonic (sarcomatous) tissue."

True osseous developments, as well as calcareous degeneration, may take place in these tumours. Sarcomatous formations may also occur, and when these have been very pronounced, secondary growths have been found in other organs.

The tendency on the whole is for most of these retroperitoneal new growths to be of the nature of myxo-lipoma. Many of them are so diffluent in character that even on the operating table they have given the impression of being in great part fluid, and sometimes have been mistaken for pus.

From an analysis of fifteen paranephric lipomata the following particulars are elicited. Nine were in females, six in males. The known duration of the disease varied from one year to eight years. Two or three years was the average.

Fluctuation was described in seven; and was stated not to exist in two. In the other six it is not mentioned.

The relations of the large bowel to the tumour were not mentioned in five, the descending colon was to the median side in two, and in seven cases the large gut was in front of the growth. In one of the latter group the sigmoid flexure, as well as the descending colon, was in front.

The relations of the kidney to the tumour varied very much. In six the kidney was embedded in the growth; in four the growth was described as taking origin from the renal capsule; in one of these the capsule of the kidney is described as continued on to the tumour; in three the kidney was carried forward in front of the tumour, which more or less surrounded the vessels or penetrated the hilum. In one the left kidney was atrophied, and embedded on the hinder portion of the tumour. In the other the tumour is simply described as "started from left kidney." In my own case, though the body of the kidney was independent of the growth, it could not be left behind in the operation, because an offset from the tumour surrounded the pedicle and penetrated the hilum of the organ.

Cestan, who collected forty cases of paranephric tumours, mostly of connective tissue varieties, states that *fibromata, or more properly, fibro-myomata* are relatively common. They arise from the proper capsule of the kidney, which normally contains smooth muscular fibres. In size they vary. Sometimes they present themselves as several lens-shaped nodules in the fibrous capsule, sometimes as a mass the size of a hazel-nut attached by a peduncle to the outer border of the kidney, but much more frequently as tumours of somewhat considerable, and even large, dimensions. In one case 2,500 grammes, in another eighteen kilogrammes, and in another forty-eight pounds, are given as the weights of the tumours. They are often very vascular; in a case of Buschmann a puncture was followed by serious hæmorrhage. They always have the external appearance, consistence, and structure of uterine fibro-myomata; cavities and cyst-like foci of degeneration may be present. The kidney is almost always intact.

Sarcomata and *myxo-sarcomata* are as frequent as fibromata and fibro-myomata. They originate, according to Cestan, in two-thirds of the cases from the capsule of the kidney, but may take origin from the pre-vertebral tissues or from the neighbouring lymphatic glands. They may attain the weight of fifteen, eighteen, or thirty-five pounds. Their outline is irregular. They form with the kidney much more intimate connections than the lipomata and the fibromata. Although in several recorded cases these tumours have merely compressed or surrounded the kidney, in many other cases the kidney has become fused with the tumour, and the tumour with the aorta, vena cava, ureter, intestines, and lumbar and psoas muscles. They may be very vascular. Jeanne has reported a case of nævoid sarcomatous tumour in the renal region, which appeared eight months after the removal of a growth of the testicle.

Symptoms.—These tumours as a rule grow insidiously and without pain, and commonly the first thing observed is an abdominal swelling, which, however, the patient is apt to attribute to ordinary corpulence or flatulence. Possibly his abdomen is increasing, whilst he is emaciating elsewhere in the body. In several instances the tumours have only been discovered at the autopsy. Neither appetite nor bowels nor kidneys may be disturbed.

The tumour is for a time on one side of the median line, though often it becomes very voluminous and occupies a great part of the abdomen, causing a prominence as great as pregnancy or as a large ovarian cystoma. Its form and hardness vary much, depending on its own consistence, its relations, and its adhesions. The same tumour may be smooth and rounded in some places, irregular, branched, or lobulated elsewhere. It may be firm and even hard, or, on the contrary, soft and fluctuating. Occupying at first the lumbar fossa and ilio-costal area, it may come to push up the liver and the diaphragm, to displace the spleen forwards and inwards, or in some cases forwards and outwards; and the colon upwards or inwards. It may not only fill the flank but descend into the pelvis and cause pressure upon the rectum and bladder. The non-malignant tumours are often very movable, but the sarcomata tend to contract very firm adhesions to the kidney and neighbouring structures. Some of the fibromyomata are pedunculated and freely movable and have simulated a floating kidney.

Galimir noticed in connection with a lipoma a peculiar sensation of crepitation when the tumour was made to glide in the surrounding tissues.

The *tumour* may give a sense of fluctuation, and yet on aspirating not a drop of fluid will escape. Fluctuation was believed to be present in seven out of fifteen cases of lipomata, and this has frequently led to a mistaken diagnosis, which has not been at once corrected even after the tumour has been exposed by an abdominal or lumbar incision. It is well known that fat often simulates fluid, so that circumrenal lipomata have come to be mistaken for ovarian cystomata, ascites, and echinococcus cysts. Thus, after repeated failure of puncture to draw off fluid, lipoma or myxoma ought to be suspected.

Pain is very rarely a symptom, and owing to this fact and to the absence of any marked functional disturbance patients often refuse to submit to any operative treatment until the tumour has reached an enormous size.

Towards the end of the case pain either of a dull or an acute kind may be felt in the loins, thighs, or external genital organs, the result of pressure on the lumbo-sacral nerves. It may occur in paroxysms or be more or less continuous, and radiate along one or both lower extremities. Less frequently instead of pain there is anæsthesia in these same parts. Œdema of the lower limbs from venous obstruction and, in exceptional cases, symptomatic varicocele is sometimes a late symptom. Œdema, like varicocele, is apt to show itself first upon the side on which the tumour originated rather than on the opposite side, or coincidently in both lower limbs. There may be ascites, and the abdominal parietes may contain much serum.

Disturbances of the *urinary functions*, in the form of uræmia, dysuria, or frequent micturition have been occasionally complained of; but hæmaturia and other changes in the urine do not occur unless the tumour by pressure on the ureter and bladder gives rise to nephrectasis with or without infection of the kidney.

In 15 per cent. some history of *gastro-intestinal disturbance* is recorded, such as vomiting, crises of intestinal obstruction, slight digestive disturbances, flatulence, colic, "functional troubles of abdominal and thoracic viscera." In a case in which I successfully removed a large retro-peritoneal lipoma with the left kidney from a lady aged seventy-one, my introduction to the patient was on account of symptoms of intestinal obstruction; the kidney, which had been displaced downwards and prominently forwards by the tumour, having been diagnosed by a consulting physician of repute as an intussusception and the cause of the intestinal obstruction.

Dyspnœa and extreme emaciation have been commonly observed as the tumours have increased in volume.

Diagnosis.—It is in most cases impossible until the tumour by slow growth has spread to a very considerable extent to make a diagnosis between renal and paranephric new growths. At the outset and for some considerable time there is nothing to distinguish the one from the other unless hæmaturia occurs as an early symptom, which it does in many cases of renal new growth, but has not to my knowledge been met with in paranephric neoplasms.

There may be the same insidious onset, the same steady progressive development, the same situation and relations of the tumour, the same kind of mobility, and the occasional occurrence of varicocele, in the paranephric as in the renal new growths.

The diagnosis so far as lipomata are concerned is very concisely put by Adami, who points out that "a retro-peritoneal" (including the perinephric) "lipoma may be suspected when there is a very slowly growing tumour situated most often more to one side than the other, accompanied by little disturbance of the general health save progressive emaciation and eventual dyspnœa; which is crossed by a length of intestine and gives a sense of fluctuation; from which repeated punctures fail to draw any fluid. The sense of fluctuation distinguishes lipoma from a fibroma; the rate of growth from a sarcoma and to some extent from a myxoma," though the diagnosis between lipoma and myxoma is admittedly very difficult.

The negative result of puncture tends to exclude ovarian and other cystic formations, and ascites.

Wigglesworth points out that in four cases of perinephric lipoma the fluctuation wave was very perfect, so that tumours of the sort occurring in women cannot positively be diagnosed from ovarian cysts except by puncture. This fact should carry with it a great caution, for no doubt was felt by all who examined Wigglesworth's case that it was a fluid tumour, and ovarian in character. In the case published by Thiriar of Brussels, a fibro-lipoma in a woman of sixty-three, weighing eleven and a half kilogrammes, was taken to be a multilocular cyst of the right ovary.

The phonendoscope of Bianchi is spoken of by Cestan as a method of real efficacy in diagnosing these tumours. He states that he has seen it used in the clinic of the Necker Hospital with excellent results, and that by its aid it is easy to localise very precisely the situation and connections of the tumour as well as the kidney. He, however, gives no example of its success.

Prognosis.—These tumours, when they are not in large part sarcomatous, are of slow growth and long duration. The average period between the detection of the tumour and its removal or the death of the patient is from two to three years. They have been known to exist for periods of seven and ten years, and even more; and when it is remembered that owing to the soft, yielding nature of lipomata they do not cause for a long time any pressure effects or any functional derangement of the viscera, it is fair to conclude that some of them have existed very much longer than the period which followed the date of their detection.

In many of the cases there has been an entire absence of pain, and of disturbance of the functions of either the urinary, abdominal or thoracic organs till within a few days of death. Emaciation may have been rapidly increasing before the tumour is discovered; it generally becomes in time very extreme. Towards the end there may be pain and œdema of the leg or legs; distressed action of the heart and dyspnœa is the common history, especially in cases where the growth extends high up beneath the diaphragm. Unless there be a large sarcomatous element the growth, when removed by operation, is unlikely to return; but when there are several separate smaller growths, it is quite possible that one, perhaps not larger than a walnut, may be overlooked, and being left behind somewhere in the retro-peritoneal tissue, may subsequently develop into a large tumour.

Periodic attacks of intestinal obstruction have been described as occurring in some of the cases. In my own case the obstruction became so serious and the displaced kidney was so much like the sausage-shaped tumour of an intussusception that I was sent for to operate on this diagnosis.

In the operation for the removal of these growths the greatest danger is that a portion of the intestine, having become much displaced by and very adherent to the tumour, may be deprived of its blood supply, so that gangrene of the bowel follows. This seems to have happened in most of the unsuccessful cases, and in some even of the operations which did not end fatally. In a few cases portions of the bowel varying in extent from seven inches to four feet had to be removed on account of injury during the course of the operation.

Although in one case an exploratory incision without removal was followed by arrest of the growth and by good health for three years afterwards, it is more than doubtful whether the arrest ought to be attributed to the operation; indeed it is difficult to suppose that it was more than a coincidence.

Treatment.—It is only when these tumours have attained a very distinct size, and are causing trouble by their weight or by their disfiguring or pressure effects, that surgical treatment is sought. In the cases which have been submitted to operation the kidney has often been found, unexpectedly, in the mass removed. In most cases of moderate dimensions the tumour will be best removed by the lateral abdominal, combined with the lumbar incision, with or without opening the peritoneum. In the case just mentioned, I removed the tumour with the kidney through an oblique lumbar incision joining a vertical incision from a point a little in front of the anterior superior spine of the ilium to the lower border of the thorax. The peritoneum was not divided. The tumour did not invade the renal substance, but was firmly adherent to the upper pole of the kidney, and could not be separated from it except by cutting into the organ. It also penetrated the hilum, and could not be enucleated along the spinal column until after the renal vessels and the ureter had been ligatured and divided. Adami, referring to the danger of injury to the blood supply of the intestine, says: "Whenever possible the tumour should be approached by a lateral or lumbar and not by any anterior incision." When the kidney can be detached from the tumour, and the ureter and renal vessels can be left intact, this should of course be done. When only one pole of the kidney is encroached upon or spread over, or embedded in the tumour, the ureter and renal vessels being uninvolved, partial nephrectomy should be performed. But in most cases either the kidney is embedded in the growth or the growth surrounds or invades the hilum of the kidney in such a manner that though its structure is quite healthy the kidney has to be sacrificed and total nephrectomy performed. Total nephrectomy is almost essential when the paranephric tumour is sarcoma.

III.—PARANEPHRIC CYSTS.

A paranephric cyst is one which is formed externally to the capsule of the kidney, in the perinephric cellular tissue, or in connection with the adrenal,* or with some remains of the Wolffian body,* or with an outlying mass of renal tissue, or with a third or accessory kidney, as in the case quoted below.

Paranephric cysts are to be distinguished from the large serous cysts developed in the kidney, and from tumours due to a dilatation of the renal cavity or pelvis. They encroach upon the surface of the kidney, and a fistulous communication may be formed between the cyst and the renal cavity.

The recorded cases of paranephric cysts other than those originating in the suprarenal gland or in fœtal remains are very few, but may be classified as follows:—(1) serous cysts; (2) hydatid cysts; (3) blood cysts.

Serous cyst.—One cyst of this kind was found in the 2,610 post-mortem records of the Middlesex Hospital, which were made during ten years. The case occurred in a woman, aged seventy-five years, who died of carcinoma of the small intestine. The ureter of this kidney was obstructed by the cancer, and the renal pelvis was dilated and filled with urine. Behind this kidney there was a large cavity containing clear fluid; the anterior wall of this cavity was formed by the kidney capsule; the posterior and lateral walls consisted of condensed perinephric cellular tissue. A small passage extended from the cyst to the dilated renal pelvis.

Cæsar Hawkins, in the eighteenth volume of the *Royal Medico-Chirurgical Transactions,* recorded a case of an aqueous encysted tumour developed in connection with a third kidney which existed in that case. It occurred in a boy, aged six; the cyst filled the entire right side of the abdomen from the false ribs to Poupart's ligament. In the walls of the cyst was a small mass of renal substance consisting of a lobule with cortical and tubular portions complete, but no excretory duct. This mass was a small third kidney. The cyst was punctured during life, and five pints of aqueous fluid free from albumen and urinary salts were found in it after death.

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* See *ante,* pp. 15 and 16.

A specimen is contained in the Museum of St. George's Hospital of a cyst which held four pints of clear albuminous fluid, and formed an abdominal tumour in a woman aged thirty-seven who died from injuries received in a street accident. The cyst protruded from the back of the renal pelvis, with which it communicated, but the pelvis was not dilated nor the ureter obstructed.

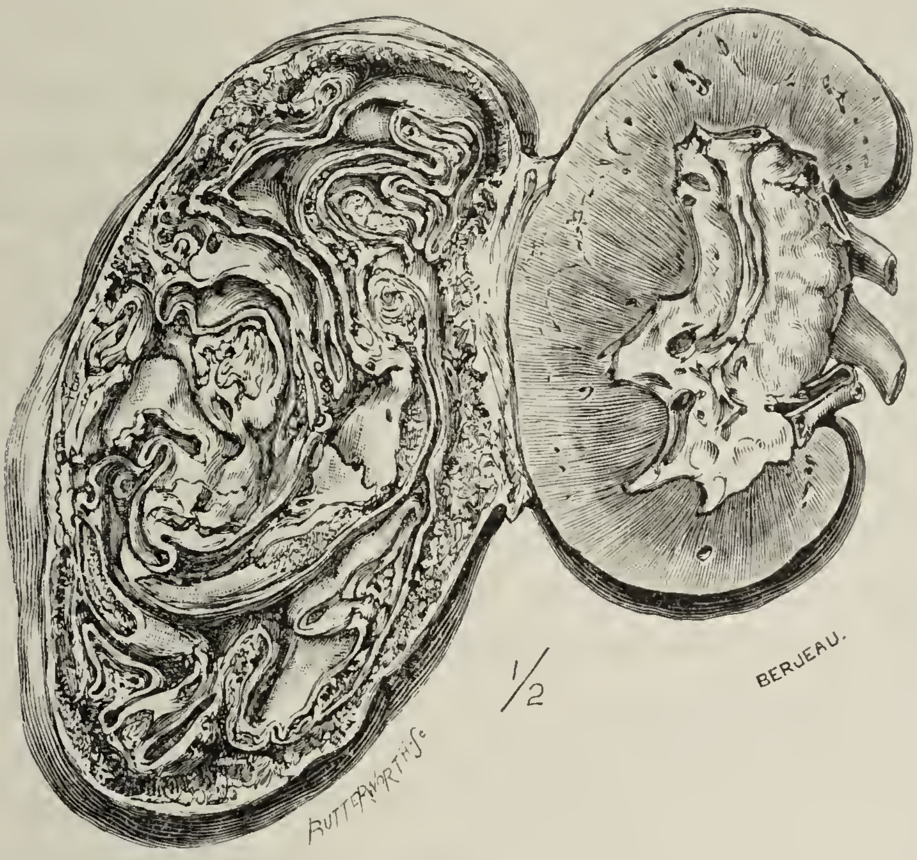

Fig. 110.—Paranephric Hydatid Cyst. (St. Bartholomew's Hospital Museum.)

Newman,* in his recent articles on cystic disease of the kidney, cites a case of paranephric cyst, the size of a goose's egg, on the posterior aspect of an amyloid kidney, completely on the outside of the fibrous capsule. It had not been suspected during life. The wall of the cyst was thin, being only one-sixteenth of an inch in thickness, and was composed of fibrous tissue only. The contents of the cyst were clear, with a sp. gr. of 1005, holding about 1½ per cent. of albumen, a trace of sodium chloride, but no organised urinary constituents. The pressure of the cyst had flattened the posterior aspect of the kidney. The patient died of amyloid disease.

Pawlik has described a large cyst behind the kidney, containing four and a half litres of clear fluid, which was quite independent of the kidney.

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* *Glasgow Medical Journal*, vol. xlvii., p. 48 (1897).

Hydatid cysts in the neighbourhood of the kidney may be easily mistaken for hydatid of the kidney itself. Dr. Gardner* of Melbourne gave three cases from his own practice: one was a suppurating cyst between the right kidney, liver, and abdominal wall; another was a small cyst between the supra-renal capsule and the liver, which contained bile-stained pus; and the third was a retro-peritoneal hydatid in front of the right psoas muscle which extended from the lower margin of the thorax under Poupart's ligament into the thigh.

In the *Australian Medical Journal* (October, 1885) Dr. Whitcombe reported a case of hydatid cyst which was adherent to the front aspect of the kidney. In the Middlesex Hospital Museum there is a very similar specimen; and in the Museum of St. Bartholomew's Hospital there is a beautiful example of paranephric hydatid cyst adherent to the convex border of the kidney (*see* Fig. 110).

Tuffier † has published a case of perinephric hydatid cyst, which was mistaken for a hydatid cyst of the kidney itself.

Treatment.—Such cases should be opened and drained, the edges of the cyst being stitched to the edges of the wound in the abdominal pariĕtes.

Blood cyst.—Hildebrandt has put on record a blood cyst containing one litre and a half of fluid blood, and not communicating with the renal cavity. He considered it was a hæmatoma due to the rupture of an aneurysm.

Blood cysts may occur from accidental rupture of vessels, or from the giving way of diseased arteries. They are almost invariably mistaken for renal cysts.

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* *Intercolonial Quarterly Journal of Medicine and Surgery*, August, 1894.

† *Bull. de Soc. Anat.*, Fév., 1890, p. 125.

CHAPTER XXIV.

RENAL CALCULUS.

In this and the next chapter I shall give a description of the varieties, pathogenic origin, symptoms, diagnosis, prognosis, and surgical treatment of renal calculus, referring only briefly to the pathological effects of calculus which have been described in previous chapters of this work; and to the medicinal and dietetic treatment of gravel.

General remarks.—There is but a step between the formation of gravel and of stone in the kidney. If the solid substances, which are usually in a state of solution in the urine, become precipitated, and if these precipitates are carried out of the system with the urine, we have the condition of gravel. If the precipitated substances are cemented together by a little mucus or some other albuminoid substance, and are afterwards added to by fresh depositions from the urine, we have a small calculus, which may either be passed off with the urine, causing more or less renal colic in its transit along the ureter, or may remain behind in one of the calyces or in the pelvis of the kidney, there to grow by fresh accretion until it attains a size altogether in excess of anything which can pass along the ureter.

Calculi originate in the uriniferous tubes and in the calyces of the kidney; but when started into being in the tubes the calculus grows into importance in a calyx or in the pelvis of the kidney.

Varieties and characters of calculi.—A division of renal calculi adopted in the classical works of Dickinson and Roberts and more recently by the French writers groups them into *primary* and *secondary* deposits. These English authorities differ slightly in their enumeration of the different varieties of calculi. Thus Dickinson mentions indigo as being a rare form of primary deposit, and gives three varieties of secondary calculi, namely, (1) the mixed phosphates (fusible calculus), (2) phosphates of ammonia and magnesia, (3) carbonate of lime. Roberts recognises only one secondary kind, namely, calculi composed of a mixture of phosphate of lime and the ammonio-magnesian phosphate (fusible calculus).

Primary calculi are composed of certain salts or other urinary ingredients precipitated from the urine in the kidney, independently of any preceding change in that organ and of any septic condition of the urinary passages; micro-organisms thus take no part in their formation.

The primary species are (1) uric acid, (2) urates of soda and ammonia, (3) oxalate of lime, (4) phosphate of lime (basic phosphate of lime, *i.e.* bone earth), (5) carbonate of lime, (6) cystine or cystic oxide, (7) xanthine or uric oxide.

Secondary calculi occur in kidneys which have been the seat of previous disease, whereby lime salts are precipitated from the urine as the result of chemical changes caused by the presence of micro-organisms in the kidney; they are the secondary effects of septic processes within the pelvis and calyces of the kidney.

Renal calculi which consist of only one ingredient are invariably composed of one or other of the first six substances enumerated as entering into the formation of primary calculi.

A calculus consisting of only one substance has usually a stratified arrangement, the layers being concentric; such is the case with uric acid, oxalate of lime, and phosphatic calculi. In cystine calculi the layers are vertical, radiating from the centre.

When primary renal calculi consist of more than one material their nuclei are invariably composed of one of these same six substances, or very rarely of a minute blood-clot; but any primary deposit may alternate with any other primary deposit, as uric acid or oxalate of lime with bone earth, or cystine with uric acid.

If a primary calculus excites, as it so often does, septic changes in the urine, the materials composing secondary calculi become deposited in layers upon the surface of the primary calculus.

Primary calculi composed of uric acid, urates, oxalate of lime, cystine, or xanthine are deposited from acid urine. A deficiency of chloride of sodium and the alkaline phosphates causes a too acid state of the urine and diminishes very markedly its solvent power over uric acid and the urates. Oxalate of lime may be deposited also from neutral urine, but very rarely.

Primary calculi composed of bone earth, acid phosphate of lime, or carbonate of lime are deposited from alkaline urine, when the alkalinity is due to the presence of fixed alkali. Such calculi are very rare in man, though, as Roberts states, they are common in the herbivora.

Secondary calculi, whether composed of the phosphates of ammonia and magnesia only, or of a mixture of the ammonio-magnesian phosphates with the phosphate of lime (fusible calculus), are deposited from alkaline urine, the alkalinity being due to carbonate of ammonia formed out of the decomposition of the urea.

The most common form of renal calculus is composed of uric acid or its salts, the next most common is the oxalate of lime. Cystine, xanthine, carbonate of lime, and basic phosphate of lime are found occasionally, though rarely, either as the nucleus or the chief constituent of primary renal stones.

Calculi composed entirely of phosphate of ammonia and magnesia, or of a mixture of the ammonio-magnesian phosphate and phosphate of lime, are always secondary to infective lesions of the kidney, *e.g.* to suppuration of the renal pelvis. But it must be borne in mind that a very considerable number of primary calculi become largely increased by these salts after their presence has set up septic conditions of the kidney.

The classification of calculi into primary and secondary, therefore, has this imperfection, viz., that there is a very large proportion of renal stones which are primary for a time, but which subsequently are added to by the same renal changes as those which produce the secondary calculi, and have all the external characters and appearance of fusible calculi.

Calculi of uric acid, oxalate of lime, and phosphates alternating in distinct layers are quite common.

Indigo forms a very rare variety of primary calculus; it is derived from the decomposition of *indican,* which is a normal constituent in small amount in the urine, and is increased in various affections, the more important of which are intestinal obstruction, peritonitis, cancer, and also simple ulcer of the stomach, and granular kidney. Dr. W. M. Ord was the first to record such a case (*Path. Soc. Trans.*, vol. xxix., p. 155). The calculus weighed forty grains and was removed after death from a healthy kidney of a middle-aged woman. The calculus was for the most part of a blue-black colour, which left a blue-black mark when drawn across the surface of a sheet of white paper, and on section was grey and polished. It gave the chemical reactions of indigo, of which its bulk consisted.

Forbes has more recently recorded a case, and figured a calculus of indigo which weighed 147 grains, removed after death from a man aged twenty-seven, who committed suicide by suffocation with the gas in his room.*

Blood calculi have been described, and inspissated blood is occasionally found as the nucleus of a mixed calculus. Dr. Scott Alison recorded a case of phthisis in which, after death, several black concretions, varying in size from a coriander seed to a horse-bean, and composed of blood of firm consistence, were found in the kidney. I have seen such concretions in the pelvis of a kidney in which a mixed calculus of uric acid and phosphates also existed. Dr. Curnow † has recorded a case of multiple oxalate of lime calculi in each kidney, the nuclei of which were blood-clots. Tuffier has met with two instances: in one the blood-clot formed the nucleus; in the other there was a nucleus of uric acid as large as a cherry-stone with a thick layer of blood-clot around it, and around this again a coating of uric acid.

Urostealith, a substance composed of fatty or saponaceous nature, has been met with as forming a concretion in the bladder; but so far as I am aware it has not been found in the kidney or ureter.

Nature of the nucleus.—The late Mr. Thomas Taylor, to whom the College of Surgeons is indebted for the analyses of the calculi in the Hunterian Museum, told me that in the great majority of cases the nucleus of a renal calculus formed in *infancy* is urate of ammonia, and in the College Catalogue he proposed to call a calculus with this sort of nucleus the infantile calculus; that the nucleus of a calculus formed in *young adult* life is uric acid; whereas that of a calculus formed after the fortieth year of life is oxalate of lime.

Parasitic origin of calculus.—The ova of Bilharzia hæmatobia have been the centre of oxalic and uric acid deposits from the urine, and if pyelitis has been excited by the presence of the ova of this parasite the mixed phosphates become added to the surface of the calculus. In one of my cases of nephrolithotomy, where I removed a small uric acid calculus from a gentleman who had passed two winters in Egypt, numerous ova of the Bilharzia hæmatobia were present in the urine; but, as he had for many years before going to Egypt passed small renal calculi, it is not probable that the ova were the cause of the lithic deposit which necessitated the operation.

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* *Med. News*, 1894, p. 187, and *Trans. of the Amer. Surgical Association*, vol. xii., p. 265.

† *Trans. Path. Soc.*, vol. xxiv., p. 148.

Primary renal calculi, like salivary and biliary calculi, have been found to contain micro-organisms in their substance, and Galippe states that calculi have always a microbic origin. Kuhne and Waldeyer have also attributed a microbic origin to primary calculi of the kidney. But several observers, Ebstein, Chantemesse, Vidal, and Tuffier, have proved the entire absence of microbes of any form in the case of uric acid calculi; and have found them, when present, only upon the surface, not in the substance of other varieties of renal stones. It is, however, not improbable that their effect upon the condition of the mucous membrane, and upon the composition of urine, might be the means of various microbes becoming the focus or nucleus around which the salts of the urine may be deposited. Rovsing also draws attention to the effect upon calculi of the bacillus coli and of the microbes which decompose urea: the latter cause the concretions to increase very rapidly by depositing phosphates, while the former, so far from having this effect, often actually destroy the concretion by growing into the organic substratum and causing the stone by degrees to crumble away.

Mr. Foulerton, the bacteriologist of the Middlesex Hospital, who has investigated the question of the presence of bacillus coli communis in calculi removed from the kidney has given to me these particulars:—

"A bacteriological examination has been made in seven cases in which calculi have been removed from the kidney either by operation during life, or after death. The calculi, immediately after removal, were placed in a saturated solution of boracic acid, and just before making the cultures were wiped over with absolute alcohol in order to destroy any bacteria which might be adhering to their surfaces. The calculi were then wrapped in pieces of sterilised cloth and broken across. Small fragments taken from as near the centre of the calculus as possible were shaken up in sterilised broth, from which appropriate culture media were inoculated. In three cases the interior of the calculus proved to be sterile of bacteria. In the other four cases pure cultures of bacillus coli communis were obtained. In one of these latter cases the extremely fœtid pus of an abscess cavity in which the calculus was contained was found to be free from bacteria. In another of the four cases pus containing bacillus coli communis and staphylococcus pyogenes aureus was present. There is no reason for believing that bacillus coli communis has any influence in causing the primary formation of renal calculi, as it is asserted to have in the case of the formation of biliary calculi. The probability rather is that an infection of the kidney by the bacillus sometimes occurs early in the history of the calculus, and that the organism thus becomes enclosed within the growing concretion."

The number of calculi.—One or many calculi may be formed in the same kidney. When the calculus is composed of oxalate of lime it is generally single; when of uric acid it is often single, but it is far less likely to be so than when of oxalate of lime.

In many cases, indeed I would say in by far the greater number of simple non-suppurative cases, in which I have performed nephro-lithotomy, there has been but one stone. In other cases there have been more than one, and in a few cases many. In one of my cases there were over 200 small stones scattered through the organ;* and in another case which I saw in consultation with Mr. Keetley, that surgeon removed 150 calculi from the right kidney of a middle-aged man.

In some suppurating loculated kidneys a separate *secondary* calculus is found in every loculus. I have removed as many as seven, eight, and nine from as many separate recesses in the same organ. A large calculus may co-exist with several smaller ones. A stone impacted in the ureter may co-exist with one or more stones in the kidney of the same side. I have published cases of this kind; and quite recently I removed a kidney from a lady containing one large calculus which weighs six and a quarter ounces, and two small calculi. Twenty days afterwards I removed nine calculi of varying sizes from the lower end of the ureter of the same side, together with the ureter as far as its attachment to the bladder.

Several calculi may be fused into one; this is more likely to occur in the bladder than in the renal pelvis. Beautiful examples are to be seen in the Hunterian and other London museums.

The size and shape.—In size and shape there is the greatest possible variety, from a small round, smooth body, or a spherical or flat or lozenge-shaped one, or one resembling a "cocked hat," to a large rough and branched mass filling all the pelvis and calyces. Much depends upon the size of the stone, and also on its position in the kidney, as to the amount of damage wrought by its presence upon the renal structure. A stone as large as a marble, rough and sharply mammillated upon its surface, may remain confined to one of the calyces for years without giving rise to more change than induration of the whole organ due to slight chronic interstitial inflammation. On the other hand, quite a minute stone, not much if any larger than a mustard or grape seed, whilst in the tubular structure of the kidney will excite congestion, acute inflammation and abscess. I have removed calculi from the kidney of all sizes, shapes, and weight; several have been more or less flattened and heart-shaped. The largest stone I have taken from the kidney during life weighed ten ounces; the smallest single stones have been three, four, five, six, and eight grains from the kidney; though I have removed from the ureter, where they have been impacted, a stone weighing in one case two and a half grains and in another less than a grain. From the same patient I have extracted from the right kidney a calculus weighing 1,303 grains, and from the left a calculus of 513 grains (Figs. 114 and 115). In some instances when two or more stones are present in the same kidney they are facetted; in one instance I removed two stones which had played upon one another like a ball and socket, the surfaces which had been in contact having been rubbed smooth and polished like a billiard ball (Fig. 111).

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* *Trans. Clin. Soc.*, 1887.

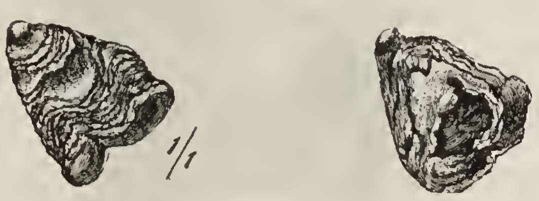

Fig. 110A.—Two views of a Calculus removed from the Kidney. (Mr. Spanton's case.)

Mr. Spanton of Hanley, in June, 1896, sent me a curious phosphatic calculus which he removed from one of the lower calyces of the right kidney of a collier, aged thirty-one. It was a solitary stone, moulded to the calyx, with a curious eaten-out hole in it, full of granuloma material (Fig. 110A). He suggests that the stone had formed round a papilla of the kidney, which became granulomatous and then ate away the edges of the stone. The man had had a sense of weight in the right loin, and occasional hæmaturia, for four years, and more recently slight pyuria.

Begouin of Bordeaux* exhibited two very curious phosphatic calculi, one the size of a hen's egg, the other of a nut, both hollow, and the larger containing purulent urine, the smaller pus. In the phosphatic material were coli bacilli similar to those found in the pus and urine. They were removed from the left kidney of an old prostatic subject, and the kidney was converted into a mere fibrous sac.

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* *Soc. de Chirurgie*, 1898, p. 1.

Chemical composition of calculi.—Uric acid and urate calculi are generally stated to be the *most* frequent of renal calculi. Roberts estimated that they constituted five-sixths of all renal concretions. Legueu, from the statistics of Billroth, Ultzmann, and Carter, says uric acid or its derivates enter into the composition of 73 per cent. of urinary calculi. Out of 649 calculi in the Hunterian Museum referred to by Beneke, 479, *i.e.* nearly 74 per cent., had urates or uric acid in their composition. Sir H. Thompson, speaking of primary as distinct from secondary calculi, says that nineteen out of twenty have uric acid for their basis, the remaining one in twenty being oxalate of lime.*

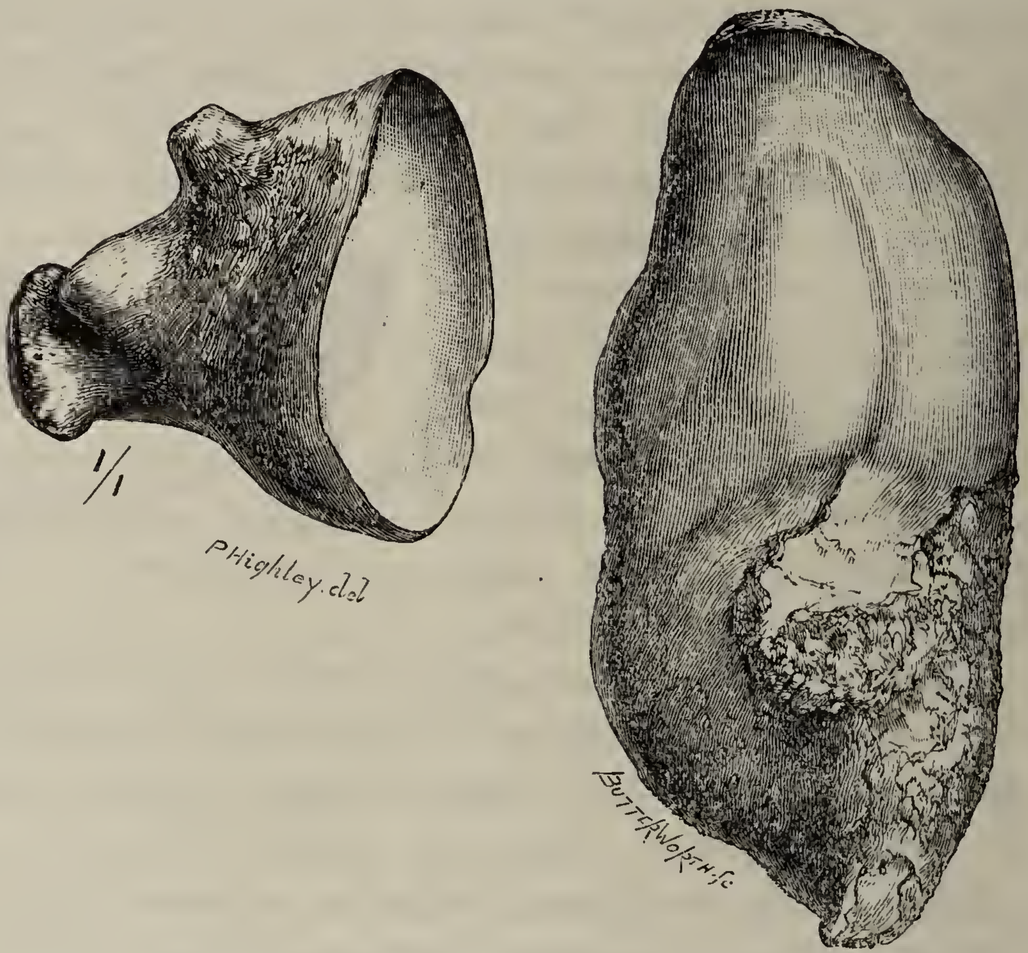

Fig. 111.—Calculi weighing 826 grains which, by friction one against the other, have become polished on part of their surfaces. Removed from the renal pelvis of the right kidney. Author's case. (Middlesex Hospital Museum.)

The figures quoted above are drawn from urinary calculi generally, not specially renal. Dickinson, who thought that the frequency of uric acid in renal concretions is less than the figures given by Bence Jones, Roberts, and Thompson represent, found uric acid or the urates in sixty-four out of ninety-one *renal* calculi, which brings the proportion up to 70 per cent., or nearly the same as Legueu and Beneke's figures for general urinary calculi.

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* *Lancet*, January 13th, 1872.

Dickinson, from an analysis of the ninety-one *renal* calculi belonging to the thirteen pathological museums of London, found that uric acid or urates occurred in less than half of the simple (as distinguished from the compound) calculi from the kidney.

It would seem, from the cases of renal calculi removed during life which I collected and tabulated from all available British and American sources between 1883 and 1893 inclusive, that other surgeons, like myself, have been unwilling to have the trophies of their surgical operations broken up for chemical analyses. Hence it happens that out of 203 published cases the chemical nature of the calculi is only mentioned in seventy-seven. Of these seventy-seven calculi, thirty-four were oxalate of lime, and only seventeen of uric acid; of the rest thirteen were phosphatic, two cystic oxide, one carbonate of lime, and ten mixed calculi. The calculi thus classed must be understood as consisting chiefly or entirely of the substances named, minute fractions of other salts not being taken into account. Mixed calculi are those which are composed of two or more salts in appreciable, though varying, quantities. By these figures it appears that oxalate of lime calculi were by far the commonest renal concretions, occurring in a fraction over 44 per cent., that uric acid stood a low second on the list, occurring only in 22 per cent., whilst phosphatic occurred in 16·8 per cent., and the mixed calculi in nearly 14 per cent.; cystine and carbonate of lime were very rare.

These figures, drawn from published records of operations for renal calculi, are misleading as regards the comparative frequency of the different varieties of renal concretions. They are probably to be explained in the following ways:—

1. That oxalate of lime calculi cause by far the worst suffering, and are therefore most likely to demand relief by operative treatment.

2. That a large number of the operations were performed before the irritation of the calculus had induced those septic conditions of the kidney in which phosphatic deposits are superimposed upon the primary formation.

3. That uric acid calculi not only cause much less suffering, but pass more readily along the ureter, and are thus expelled *per urethram* or develop as vesical calculi.

4. That uric acid calculi are far more frequently bilateral, and often cause death from calculous anuria, instead of being removed by operation.

5. That cases in which kidneys have been removed for calculous disease may have been published under the heading of nephrectomy, or some other title not indicating their calculous nature, and may thus have escaped being included in my lists.

6. That the great majority of patients operated upon for stone in the kidney are of an age between twenty and forty-five, a period of life in which there is less tendency to the excessive formation of uric acid.

Still these figures tend to the conclusion to which my own impression, derived from the chemical analysis of a few and the naked-eye appearances of the rest of the renal calculi which I have removed by operations, inclines—viz. that uric acid does not enter quite so commonly into the composition of renal concretions as is usually supposed, and that oxalate of lime is a much more frequent form of renal calculus than the recognised authorities have led us to believe. In reference to this statement, however, exception must be made of the late Dr. Hilton Fagge,* who showed that in persons past early adult life calcium oxalate calculi are, contrary to the general belief, of much greater frequency than those of uric acid.

The **colour and consistence** vary with the chemical nature.

Pure uric acid.—These stones are hard, smooth, and of yellow-fawn or red colour. Occasionally their colour is brilliant and highly polished and much darker.

Urates.—Renal calculi consisting only of urates are seldom met with. They are light yellowish in colour, and of a soft, friable texture. They are always of quite small size, and are peculiar to children.

Oxalate of lime calculi are very hard and insoluble, irregular on their surface, sometimes mulberry like, sometimes coated with little sharp spines or rough minute beard-like nodules; they are greyish brown or brownish black and, more rarely, quite black in colour.

I have removed on several occasions oxalate calculi, weighing from twenty to forty grains, of a flattened, biconvex, triangular, or heart-shaped outline, the surfaces of which have been made rough by small pinhead sized elevations. Oxalate of lime calculi sometimes take the form of small polished spherical bodies of a yellow or dark, or even black colour. The latter resemble poppy seeds, and are sometimes spoken of when excreted as "black gravel."

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* *Medicine*, vol. ii., pp. 373–383.

Phosphatic calculi.—Fusible calculi (*i.e.* mixed phosphates) are grey or whitish grey, very friable, not always stratified, and resemble dried mortar or dirty chalk. Many of them have studded over their surfaces brilliant minute icicle-like transparent sharp crystals of triple phosphates, giving a sparkling appearance when freed of pus, blood, or purulent urine (Fig. 112). These are deposited from ammoniacal urine.

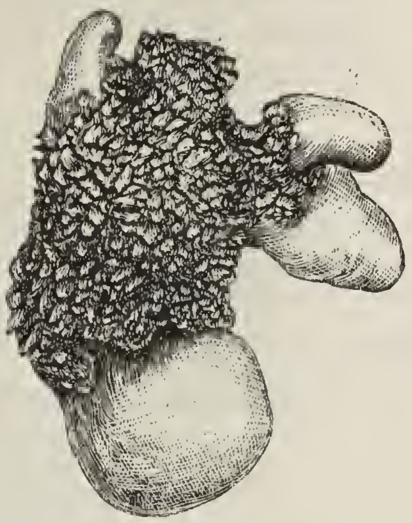

Fig. 112.—Calculus weighing 213 grains removed from the renal pelvis of a young man aged 25, in 1887. The surface is in part studded with acicular particles of triple phosphates. (*See* "Hunt. Lect.," Table I., No. 4.)

Calculi of unmixed phosphate of lime or bone earth are chalky or grey in appearance, laminated on section, and polished on their surfaces. They are derived from alkaline but not ammoniacal urine, and are very rare; they usually soon become coated with the triple phosphate or the mixed phosphates. Slee* has published a case of primary phosphatic calculus found in the kidney which weighed fifty-two grains.

Calculi of ammonio-magnesian, or triple phosphate, are grey or greyish-white, porous-looking, and mortar-like or chalky when dry. They may be in part confusedly crystalline, in part laminated. They are deposited from ammoniacal urine.

Carbonate of lime—Calculi of carbonate of lime are often formed in the prostatic ducts, and occasionally originate in the kidney. They are small, round, yellowish-grey or bronze coloured, sometimes with a metallic lustre, translucent, very hard, and finely laminated. There are at least two recorded cases (Wagstaffe's and Haldane's) in which concretions of carbonate of lime were formed within the kidney as a primary calculus. The usual size varies from that of minute grains of sand to a hazel-nut. In Wagstaffe's case† a large branching calculus, a quantity of brown sand, and several small rounded loose calculi were removed (post mortem) from the right kidney of a man aged forty-two. In Haldane's case (Roberts, p. 327) half a teaspoonful of sandy particles, concreted or held together by an animal matrix, were found in the pelvis of the left kidney of a man with caries of the spine.

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* *Medical News*, 1893, vol. ii., p. 663.

† *Trans. Path. Soc.*, vol. xix., p. 270.

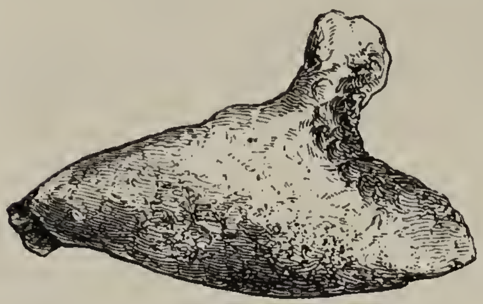

Fig. 113.—Calculus weighing 109 grains removed through the anterior surface of the kidney in 1888. From a woman aged 26.

Wagstaffe described five different forms (all carbonate of lime) of calculi in his case; some like uric acid, some like phosphatic, some like crystalline triple phosphates; some little brownish spherules, very hard, and like prostatic calculi. They had a distinct animal matrix.

Cystine or cystic oxide.—Calculi of this material are soft, of crystalline structure, and have a yellow colour, which after exposure changes to a pale green.

Xanthine or uric oxide calculi are smooth, of the hardness of uric acid, and of a yellowish, or brownish, or a peculiar flesh or reddish cinnamon tint. When rubbed they acquire a waxy or resinous lustre. One stone described by Dr. Marcet, the

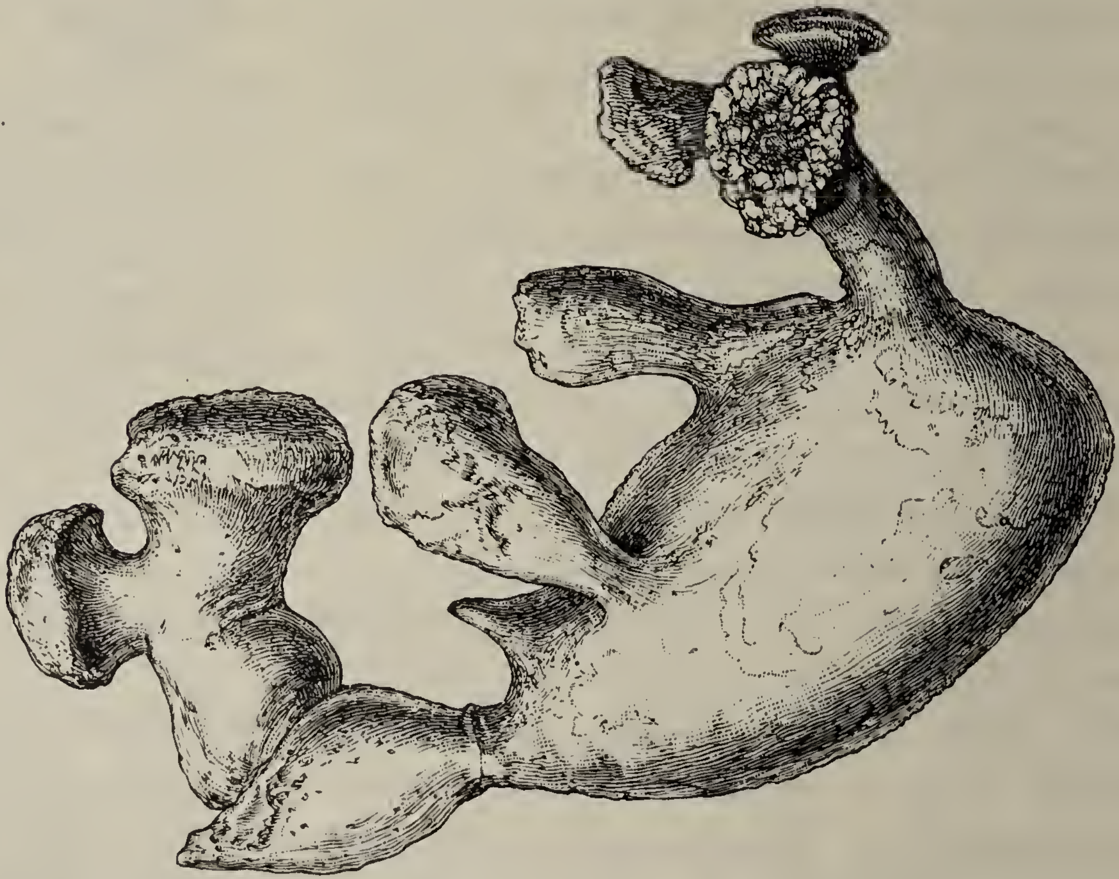

Fig. 114.—Calculus weighing 1,303 grains removed from the Right Kidney in 1889. Same patient as Fig. 115. (*Brit. Med. Journ.*, 1893, vol. i., p. 4.)

discoverer of these calculi, was of a reddish cinnamon colour, compact, and laminated. One presented by Bransby Cooper to the Hunterian Museum as a uric acid calculus, mixed with urate of ammonia, calcium oxalate, and traces of earthy phosphates, was found by Mr. Thomas Taylor to consist of almost pure xanthine.

Indigo forms a hard calculus, granular on the surface, and of a dark brown and blue-black colour. It leaves a blue mark when drawn across white paper, and gives the chemical characters of ordinary indigo.

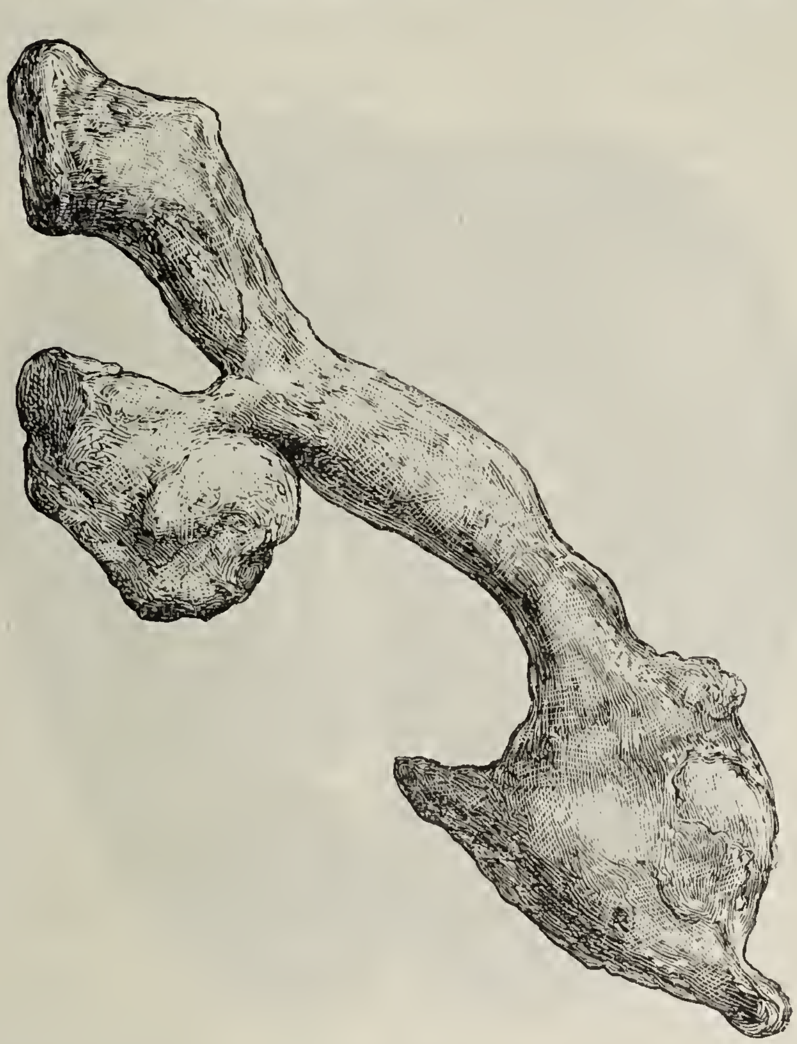

Fig. 115.—Calculus weighing 513 grains removed from the Left Kidney in 1890. Same patient as Fig. 114. (*Brit. Med. Journ.*, 1893, vol. i., p. 4.)

The parts of the kidney occupied by calculus.—The calculus is generally situated in the renal pelvis or one of its calyces, but in some cases calculi of small or medium size, weighing from a grain to thirty grains or more, are embedded in the parenchyma. In Spanton's case the calculus was thought to be capping the papilla, to which it was closely adherent. When in the parenchyma the stone may be near the surface of the kidney, separated from the fibrous capsule by only a thin layer of the cortex. So situated the stone may cause a localised renal abscess, which subsequently may burst into the perinephric tissue.

A calculus of small or even of medium size may be so embedded in the parenchyma or in the depth of a calyx as to be quite undetectable until the kidney is incised. Spanton found an entire absence of any feeling of stone even when the kidney was outside upon the loin and freely handled. This has been my experience in several cases since I first drew special attention to this fact several years ago.*

A calculus in a calyx may move slightly or be quite fixed; one in the renal pelvis may move freely and fall from time to time over the ureteral orifice, causing temporary obstruction. A calculus may take the form of the renal pelvis, or of the renal pelvis and one or more calyces into which it branches. In pyonephrotic organs the whole cavity may be occupied by one large branched calculus, or several isolated pouches may contain each a separate calculus. A calculus may be so moulded to the renal pelvis as to fill it and be adherent to it. I have had to peel off the distended renal pelvis just as one strips sticking-plaster from the skin or the rind off an orange. Mr. Wheeler mentioned, at a meeting of the Royal Academy of Medicine in Ireland, having seen, post mortem, a horse-shoe kidney both lateral masses of

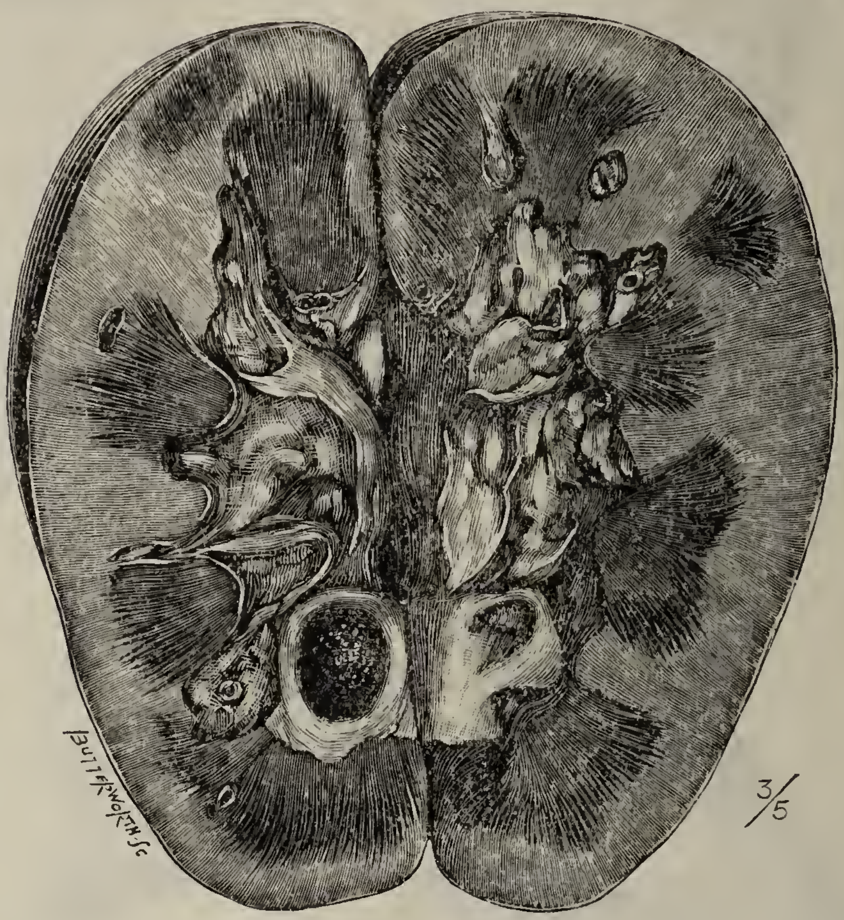

Fig. 116.—Kidney with Calculus *in situ*, removed in 1884 by lumbar nephrectomy after failure to find the calculus by exploring the kidney. (Author's case.)

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* *See Trans. Med. Chir. Soc.*, vol. xviii., and the reports of the discussion thereon in the medical journals of November, 1884.

which were quite healthy while the connecting band contained two calculi.*

The relative frequency of bilateral renal calculus.—One or both kidneys may be affected at the same time, or one may become so subsequently to the other. When due to a local cause, such as injury, tubercle, or a sarcomatous, carcinomatous or papillomatous growth in the kidney, only one organ is the seat of stone.

Legueu—and Albarran agrees with him—states that one or several calculi are found in both kidneys in nearly 50 per cent. of cases. In seventy-six instances in which the state of the two kidneys is described, Legueu found that there were calculi in both kidneys in thirty-eight.

Figures which are taken from post-mortem records, however, are calculated to give an undue proportion of bilateral cases. Many such patients meet with their death from calculous anuria, and it is not surprising that when one kidney has for long been destroyed by calculous disease the other kidney, working alone in a person with a strong tendency to lithiasis, should subsequently produce a calculus. Figures drawn from my own operations (nephro-lithotomy, nephrotomy, and nephrectomy) for calculus yield a very much smaller proportion of bilateral cases—not more than 10 per cent. It has happened to me to have to perform a second or even a third operation upon the same kidney in nearly as large a proportion of cases. Of these patients upon whom I have operated twice for calculus in the same kidney, in some both kidneys, in others only one have been the seat of calculus. It might at first thought be expected that both kidneys would be the seat of calculus if one is. It is not readily explicable how lithiasis which presumably affects the two kidneys equally should result in unilateral renal calculus if the two organs are previously equally sound. The fact is, however, that urinary salts are sometimes found to be unduly eliminated by one kidney and not by the other. The employment of the ureteral catheter and the opportunity which this instrument has given for making separate examinations of the urine from each kidney has shown that crystalline deposits found in the urine may be unequally produced in the two kidneys.† If the quantity of uric acid crystals, for example, contained in the urine secreted by one kidney is sufficient, and that in the urine secreted by the other is insufficient to excite those epithelial changes whereby the albuminoid substance which forms the organic basis of every calculus is formed, we can understand how the uric acid or its salts, whether held in suspension or dissolved in the urine, become deposited and strongly united together to make a calculus in that organ in which the crystalline formation is the greater.

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* *Brit. Med. Journ.*, 1894, vol. i., p. 526.

† W. Meyer, *Medical Record*, May 1, 1897, p. 617.

Etiology.—*Age.* Renal calculi are formed at all periods of life, from the later weeks of intra-uterine existence up to quite old age. It is, however, in the middle periods of life, or between the ages of twenty and fifty, that renal calculous affections chiefly occur. There is thus a great difference between vesical and renal calculus. Stone in the bladder in children of the better classes is very rare, but in the poorer classes the patients with vesical calculus are predominantly children, whereas in the well-to-do classes they are chiefly men past middle life.

Out of ninety-six operations for renal calculi which I had performed up to 1898 and which are tabulated in my Hunterian Lectures, twenty-seven were in persons between twenty and thirty years of age; twenty-eight in those between thirty and forty; and twenty-two in those between forty and fifty. Seven of the patients were between ten and twenty; seven over sixty; and five over seventy years of age.

Out of 203 cases of renal calculus which I collected from all English-speaking sources between 1883 and 1893 (182 of which underwent an operation), the age, is given in 188: only one patient was under ten years of age; ten were between ten years and fifteen years; twenty between fifteen years and twenty years; fifty-four between twenty and thirty years; fifty between thirty and forty years; thirty-four between forty and fifty years; seventeen between fifty and sixty years; two between sixty and sixty-five years. It should be understood that the ages mentioned are the ages of the patients when coming under treatment; but in many of the cases the disease was known to have existed years before the patients were subjected to operation.

In some of my own cases of operation for renal calculus, the symptoms went back for thirty, twenty-three, twenty, twelve, ten and nine years. It is interesting to note how early in life the calculous symptoms began in some of the cases: thus a child of thirteen when operated upon had had symptoms for seven years; one of eleven years of age when the stone was removed had suffered for three years.

Uric acid, and concretions of minute size composed of urate of sodium or ammonium in combination with an albuminoid substance, are fairly common in infants (Fensburg), and have been frequently found after death in the kidneys of the new-born and the fœtus at term. But the microscopic dimensions of these deposits and the fluid diet of early infancy allow of their becoming redissolved, or else being washed along the ureter into the bladder and thence out through the urethra. Mr. Cadge attributed the frequency of vesical calculi in the children of the poor to the absence of milk from their dietary.

Emmett Holt* states that on post-mortem inspection fine brown granules are frequently seen in the renal pelvis and calyces of young infants; and that occasionally a calculus as large as a small pea is found. They are usually composed of uric acid. The granular deposits are generally seen in both kidneys of the same infant; with the larger collections there is usually a slight catarrhal pyelitis. Only once in a thousand (1,000) autopsies of which Mr. Holt has records was a stone of any considerable size seen in an infant. In this case the calculus was an inch in length and half an inch wide, and as is very often the case with renal calculus in children, there were no indications during life of the presence of the stone.

Dr. Newton Pitt † records the case of an infant fifteen months old in the pelvis of whose kidney was found after death a uric acid calculus weighing over four grains, and in another case, of a child of eleven months old, a uric acid calculus weighing over two grains was found. Both children died of diphtheria.

Ducamp d'Orgas ‡ states that evidence of lithiasis was found in the kidneys of forty out of 170 infants who were examined after death, and that in one out of five there were minute rounded concretions and not merely gravel. Dr. Gibbons, from his experience at the Grosvenor Hospital for Women and Children, London, gives as the explanation of severe paroxysmal attacks attended by pain and disturbances of micturition—in both male and female infants of from a few months to three years of age, the offspring of gouty parents—an excess of uric acid which agglomerates into masses the size of a hemp-seed with the aid of mucus, and excites spasm in its passage down the ureter.

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* "Diseases of Infancy and Childhood," p. 630.

† *Path. Soc. Trans.*, vol. xlvi., p. 90 (1895).

‡ "Thèse de Paris," 1897.

In several cases in which I have either been consulted or called upon to operate for renal calculus the history of the illness has favoured the idea that the calculus originated in very early childhood. I have, however, only once, and that quite recently, had occasion to operate for stone in the kidney in a child under ten years old: in that case the little patient was a boy, four years of age, and a small uric acid calculus had excited an abscess in the renal parenchyma which burst into the perinephric tissue, and subsequently a fistulous opening was established in the loin. A perinephric abscess had been thus discharging for between three and four months when I first saw the patient. Nephrectomy was necessitated, and recovery ensued.

Northrup of New York recorded a case of a little girl aged thirteen months who died without having had any symptoms referrible during life to the genito-urinary tract, yet there was a large uric acid calculus filling the pelvis of the left kidney, and three uric acid calculi varying in size from a pea to a filbert lay in the pelvis of the right kidney, which was in a state of advanced suppurative pyelo-nephritis.

Stanmore Bishop* records the case of a male aged thirteen, and another seven years of age, in each of whom a calculus impacted at the vesical end of the ureter was removed by suprapubic cystotomy.

Mr. George Heaton† has recorded two cases of nephrolithotomy in children. One a male aged nine, with symptoms simulating typhoid fever, from whose left kidney a calculus of uric acid weighing 38 grains was removed; the other a female aged eleven with lumbar pain and hæmaturia, from whose left kidney two uric acid calculi weighing respectively 35 and 5 grains were removed.

Quite recently M. Léon Bernard‡ has published an essay on calculous hydro-nephrosis in the earliest infancy; but though he relates cases he has observed of hydro-nephrosis not caused by any congenital malformation, and therefore as he thinks presumably due to renal lithiasis in children under one year of age, he gives no case in which he has found post-mortem evidence of calculous obstruction in the ureter or renal pelvis of these infants. He does not state whether he was able to exclude phimosis, and minute cysts or primary valves in the ureter or urethra, which my own observation of cases of hydro-nephrosis without obvious origin in children who have died under one year of age has led me to regard as the most probable causes of hydro-nephrosis. The twists or secondary valves in the ureter which result from long-continued obstruction of any kind are of course too obvious to be overlooked; but a small cyst in the mucous membrane, or a little semi-lunar fold in the tiny ureter or urethra, is amply sufficient to cause in time enormous dilatation.

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* *Edin. Med. Journ.*, July, 1899.

† *Birmingham Medical Review*, Sept., 1897, p. 143.

‡ *Ann. des Mal. des Organes Génito-urinaires*, Février, 1900.

There are many cases in which vesical calculi of large size containing uric acid have caused cystitis and uretero-pyelo-nephritis with renal distension in children under twelve years of age, but these do not fall into the subject now under consideration. In one case a xanthine calculus weighing 90 grains was extracted from the bladder of a Mussulman child, aged four years.*

Sex.—The male is more frequently affected than the female, but with renal calculus there is nothing like the disparity between the sexes that is observed in respect to vesical calculus; the latter is very rare in the female. This difference is explained by the much greater ease with which a renal calculus which has once entered the bladder can escape externally in the female than in the male.

In a collection of 203 operations for renal calculus it was found that the two sexes were almost equally involved, ninety-four of the patients being men and 109 women (Tuffier). By a coincidence 203 is the number of cases of renal calculus (182 of them were operated upon) which I collected from all English-speaking sources between the years 1883 and 1893, and of this number 124 occurred in males, seventy-six in females, and in three cases the sex is not stated. Adding these figures together, in a total of 406 cases there were 218 males and 185 females, and three of whom the sex is not stated.

In my own experience the proportion of males to females is distinctly higher, for out of ninety-six operations for renal calculus which I had performed up to the beginning of the year

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* *Path. Soc. Trans.*, vol. xix.

1898 (*see* the tables in my Hunterian Lectures), thirty-five concerned females and sixty-one males. The lithiasis of infancy is also from two to three times more frequent in males than in females.

Heredity plays a distinct part in the causation of renal calculus. It is a common thing in practice when inquiring into the family history of a patient with renal calculus to be told of one or more immediate relatives of the patient who have suffered from stone.

Leroy d'Étiolles gives the history of eight brothers, all the subjects of lithiasis, yet all living in different parts of Europe and under very different circumstances as to hygienic surroundings and climate.

The hereditary tendency to stone is specially marked in the case of calculi composed of uric acid and its compounds. The hereditary nature of the uric acid diathesis is shown by the presence of uric acid infarcts in the kidneys of new-born children, and therefore before independent conditions special to the individual child can have induced it.

It is through the complex disturbances of nutrition and the influence of the nervous system over them that the excessive formation of the urinary salts is due; and in this way is probably to be explained the connection of rheumatism and gout with renal calculus, and the hereditary tendency to these formations.

Side affected.—Both kidneys are equally liable to the disease; thus, out of 203 cases, the stone was in the right kidney in eighty-six instances, in the left kidney in eighty-two cases; both kidneys were affected in nine cases, and in twenty-six cases the side is not stated.

Personal habits. — A sedentary and physically inactive life, rich and savoury diet, salted and smoked meats, game, alcohol in all its forms, and in general terms a dietary too highly nitrogenised or too abundant in salts are conducive to the formation of renal concretions. Stone is more common in the beer-drinking districts of the United Kingdom than in those where the local beverage is cider or whisky.

Impregnation of drinking water with lime.—The frequency of oxalate of lime as the nucleus of renal stone (whatever the body of the calculus may consist of) is considered to point to the origin of calculus in water highly charged with lime. Dickinson states that he has frequently found urinary deposits of oxalate and phosphate of lime (not uric acid or urates) result abundantly from the experimental administration of lime water and other preparations containing lime salts; crystals of oxalate of lime, often of large size and in great abundance, constantly appear after the use of such medicinal preparations, and after the ingestion of earthy salts.

On the other hand, Denys has attributed the great frequency of stone in Holland to the absence of earthy salts in the water; and if hard waters are diuretic, as they are said to be, their absence may indeed be a predisposing cause of a frequency of uric acid calculi.

Climate.—The investigations of Mr. Cadge of Norwich seem to show that cold has no effect in the production of calculus, but rather the reverse. He points out that urinary calculus is less frequent on the coast of Norfolk, where the cold is greatest, than in the inland villages; and that it is rare in Sweden and Norway but common in India and parts of China.

In India, both Europeans and natives suffer from calculous disorders, though these are much more common amongst the natives. It can hardly be questioned that the more concentrated the urine the greater the tendency to precipitation and crystallisation of its salts, and the greater the irritation in the urinary tubules, which is likely to lead to the formation of the mucus or other albuminoid substance which enters into the base of every calculus. This being so, and, allowing for other influences, such as diet, drink, and personal habit, it is only natural that calculus should be formed more frequently in warmer than in colder climates.

The mechanical retention in the kidney of the precipitates from the urine.—It is very difficult to understand why in some persons a small calculus, or large quantities of gravel sufficient to form a calculus of considerable size, are painlessly passed off from the kidneys in the course of a day or two, whilst in another person a small globule not larger than a grain of mustard-seed remains behind in the renal tubules or the cavity of the kidney, there to grow into a calculus of smaller or larger size; or passes along the ureter with great difficulty and with agonising pain.

The size of the precipitated crystals, the sharpness of their angles, the roughness of their surface (which gives them a greater tendency to adhere to the wall of the urinary passages), and the presence of mucus, blood, or other albuminoid substance (whereby the crystals as they precipitate are cemented and agglutinated together), are factors strongly in favour of the formation of stone, and adverse to the free escape of the urinary deposits.

Crystals of uric acid and oxalate of lime form concretions very readily, and oxalate of lime has a great tendency to cohere. The urates and phosphates, though they adhere to any dead surface, have very little disposition to concrete.

The persistent presence of decomposing urine in the bladder may give rise to a fusible calculus in the kidney. I have in several instances seen one or both kidneys occupied by phosphatic stones as a secondary effect of obstructed ureter or of a stone or growth in the bladder. The fact is easily explained as the effect of an ascending ureteritis leading to pyelitis.

Injury.—An injury may lead to the formation of a calculus around a blood-clot as a nucleus, or by setting up some inflammatory aseptic lesion. Again, a stone previously securely lodged and latent or quiescent, may be dislodged by violence and become a source of active symptoms and pathological changes. A history of injury of an indefinite kind is often given by the patients to explain the causation of their calculi; but in most cases the true explanation is that an unsuspected calculus, which so long as it had remained fixed in position gave rise to no symptoms, was dislodged by the fall or injury and then its presence for the first time at once became declared.

The pathogenic origin; the determining causes of the formation of renal calculi.—As different kinds of calculi arise from very different causes we will consider each variety from this point of view separately.

Uric acid diathesis; lithæmia.—Uric acid is deposited more commonly before the tenth and after the fortieth year than in the intermediate period of life. It is derived in part from food and in part from the metabolism of the tissues. It is a means of exit of a certain proportion of nitrogenous waste. About one gramme is excreted normally in a day. Uric acid when oxidised in the presence of water out of the body is converted into urea; it has been considered that the same change is constantly in progress within the body and that uric acid is an intermediate stage between albumen and urea. It has also been inferred that uric acid is formed in the liver and spleen. The present teaching is that it is the ultimate product of the metabolism of nuclein, which exists in the food as well as in the body.

Uric acid may be in excess without being deposited. This is the case in concentrated, highly acid febrile urine which, containing a large quantity of salts and colouring matter, deposits urates, not uric acid. On the other hand, uric acid may be deposited without being in excess, as in the case of dilute urines deficient in salts and colouring matter; in scarlatinal nephritis and renal cirrhosis. As a general rule the precipitation is due to an absolute excess caused by a diet too rich in nitrogenised food. Its deposition is influenced mainly by the acidity of the urine. Alkaline urine holds uric acid in solution. A free acid in the urine by decomposing the urates causes the precipitation of uric acid. On the other hand, the salts of the urine keep the uric acid soluble in the form of a quadriurate. Hence urine, whether concentrated or diluted, if it contains a free acid or is deficient in a due proportion of salts, has a tendency to deposit uric acid.

The causes which lead to the precipitation of uric acid are deficiency in oxygen and too great an amount of nitrogen, *i.e.* too little fresh air and exercise, an abuse of alcohol, and too much nitrogenous food, whether animal or vegetable; anything which causes hepatic congestion; gout, ague, pernicious anæmia and leukhæmia, febrile diseases, gouty forms of diabetes mellitus, and dyspepsia, associated even with a coarse and poor diet.

Uric acid is deposited from all urine after many hours, but if it is precipitated within four or five hours of being voided, it indicates a risk of the formation of stone in the kidney or bladder.

Urates of sodium, potassium, calcium, and magnesium are the commonest of urinary deposits. Uric acid is normally excreted in the form of quadriurates of these bases. These quadriurates are soluble in cool as well as in warm urine, if the fluid is not too concentrated; if the urine is very concentrated they are held in solution in warm urine, but are deposited when the urine cools. The decomposition of the quadriurates results in biurates and uric acid. Urates are deposited when the quantity of water in the urine is insufficient. As a rule the deposition of urate of soda is due to an absolute excess of this salt in the urine. Febrile states, dyspeptic and chronic gastric affections, and the venous congestions resulting from cardiac, pulmonary, and hepatic diseases are the conditions which favour the abundance of urates in the urine. The acid sodium and ammonium urates, and more rarely the other urates also, occasionally occur in a crystalline form: these crystals are often spiny, and cause great irritation in the urinary tract of children, leading sometimes to temporary suppression of urine (Bradford).

Infarcts of amorphous lithates mixed with uric acid have been found by many observers in the straight tubes of children who died soon after birth. Associated with such infarcts, red gravel has frequently been seen in the renal pelvis and the urinary bladder, and this has probably often become the nucleus of a vesical calculus. In this way is explained the frequency of stone in the bladder in childhood.

Oxalate of lime, the oxalic diathesis, oxaluria.—This is more common in men than in women, and affects nervous, active, and irritable persons, especially those who lead studious, sedentary lives. A minute quantity (twenty milligrammes, about) of oxalic acid is normally excreted daily in the urine in the form of calcium oxalate. This salt is kept in solution by the acid phosphate of soda of normal urine. A scanty deposit of the crystals of calcium oxalate is not inconsistent with health; when there is an excess of excretion of oxalic acid, oxaluria is said to exist, and risk is run of the formation of an oxalate of lime calculus. When oxalate of lime is constantly present in abundant pale urine, it generally indicates a constitutional defect; when in high-coloured urine it probably results from the decomposition of urates, and has no clinical importance (Dickinson). It is thought to be associated with malaria and ague, to be developed in persons living in damp districts, and to cause urgency and frequency of micturition in adults, nocturnal incontinence in children. The crystals of oxalate of lime are envelope (octahedra) or dumb-bell shaped, and are found within the straight tubes or in the renal pelvis or calyces. Often microscopic lumps or masses of such crystals (miniature calculi) may be found, and if one of these becomes impacted upon some part of the epithelial membrane of the kidney, it will in all probability form the nucleus of a renal calculus. Such deposits occur in children, and the origin of several of the oxalate of lime calculi met with in adults can be traced back to childhood.

Certain articles of food, such as rhubarb, gooseberries, tomatoes, and sorrel, contribute to its appearance in the urine; and it has been thought that a too vegetable diet, sugar and starchy foods, combined with dyspeptic troubles, explain the comparative frequency of oxalate of lime calculi in persons of the poorer classes.

Oxaluria is certainly present in many dyspeptic and neurasthenic persons, but the dyspeptic symptoms and mental depression are often due to the oxaluria, and not the oxaluria to the dyspepsia and neurasthenia. It is equally certain, however, that overstrain of the nervous system and inattention to the digestive organs tend to cause oxaluria. Many persons have an oxalate of lime calculus in one of their kidneys without any symptoms except those caused by the calculus: others have oxaluria with dyspeptic and nervous troubles, but no renal calculus.

Oxalate of lime is rarely precipitated except in acid urine. It has been shown that uric acid is convertible into oxalic acid and urea by the addition of oxygen and water, and oxalate of lime and uric acid alternate frequently in the same patient. Owen Rees showed that urine containing urates, when heated, yields oxalate of lime, and he thought this conversion was the only source of oxalic acid in the urine. Claude Bernard produced it experimentally by injecting uric acid into the blood. There is evidence to show that oxalate of lime is produced in the urine if oxalic acid is taken in the food; hence the effect of the vegetable substances named above. It is certain, however, that oxalic acid is formed in the system when all foods known to contain it are avoided; and Chabric, who confined himself for a month exclusively to substances rich in oxalic acid, failed to find oxalic acid once in his urine. Dickinson thinks that the development of oxalate of lime is much more dependent upon the lime than upon the oxalic acid swallowed. Lime ingested provokes an abundant excretion of oxalic acid. Bence Jones taught that the oxalic diathesis, like other forms of acidity, is a result of the insufficient action of oxygen upon the hydrocarbons of food, the process of oxidation being checked at the stage of oxalic acid instead of transforming them into carbonic acid and water.

Phosphatic calculi and the phosphatic diathesis.—From two to six grammes is the normal daily excretion of phosphoric acid in the urine. It is passed off in the form of phosphates of potash, soda, lime, and magnesium: the bulk of it is normally united with potash and soda. The phosphates are derived chiefly from the food, partly from the tissues; the neutral or alkaline phosphates and the earthy phosphates of the urine are precipitated when the urine becomes alkaline. Phosphate of lime (or bone earth), and phosphate of magnesium unmixed with the ammonio-magnesic phosphate, is a secretion and is deposited by urine simply because it is wanting in acidity. Ammonio-magnesic phosphate is not a secretion but the product of the decomposition of urine by which ammonia is formed from urea. So long as decidedly alkaline urine remains free from ammonia, phosphate of lime will be precipitated without any ammoniacal admixture; and a stone, if one be found, will be composed of unmixed calcic phosphate; but when this rare primary concretion excites, as it soon does, sufficient irritation of the mucous membrane to make the urine in the renal cavity ammoniacal, a precipitation of ammonio-magnesian phosphate or of the mixed phosphate results, which is bound together by the tenacious mucus, or muco-pus, and thereby a secondary incrustation is added to the primary formation. An oxalate of lime or uric acid calculus, or a clot of blood, may equally give rise to an enlargement from fusible or mixed phosphates. The causes of the urine becoming alkaline from fixed alkali are the deficiency of acid, especially of phosphoric acid, or an excess of alkalies or of lime: a depressed or anxious state of the nervous system, gout, phthisis, granular disease of the kidney, chronic gastric disturbances, and the administration of alkaline medicines or fluids containing lime are the conditions found associated with this state of urine.

The cause of ammoniacal urine is to be found in a local disease (inflammation) of the lining membrane of the urinary organs, and is therefore not an error of secretion but a change subsequent to secretion. This change is brought about by a discharge from the mucous surface of the renal pelvis or bladder, and the presence of bacteria which act as a ferment and causes decomposition of urea.

Catheterisation, tubercle, stone in the bladder, lesions of the spinal cord not rapidly ending in death, and any cause of obstruction to the ureter, may provoke an ascending infection and the formation of a fusible or mixed phosphatic concretion.

Carbonate of lime is precipitated under the same conditions as the phosphates. If deposited as a primary concretion, it is probably owing to the great capacity of carbonate of lime to aggregate into spherules, whilst the phosphates are passing off. When it enters into the formation of compound calculi, it occurs as a sequel to or in company with the earthy or triple phosphates; when with the latter salt the carbonate of lime is precipitated from ammoniacal urine by the carbonate of ammonia acting on the oxalates and phosphates. Ebstein states that the oxalates are transformed also into carbonates under the influence of micro-organisms. Carbonate of lime is prone to be precipitated in the form of a calculus when pus or other morbid products are mingled with the urine. “There is reason to believe that of all calculi those of carbonate of lime are most closely dependent in their origin not so much upon urine as upon pus and other products of disease within the urinary cavities” (Dickinson).

Cystine calculi and cystinuria.—Cystine contains 25·5 per centum of sulphur. Healthy urine contains sulphur in an unoxidised state, as well as in the form of sulphates; and cystine itself exists in the blood and occasionally in the urine. Calculi, both of cystine and xanthine, are said to be derived from uric acid, but what determines their precipitation is unknown. Cystine sometimes alternates with uric acid as a precipitate from urine. In calculi it generally occurs alone, but may be deposited upon uric acid, or variously associated with phosphates, oxalates, and urates. Occasionally a cystine calculus is coated with phosphates.

Its most striking clinical feature is its tendency to run in families. Poland showed that out of twenty-two collected cases of cystine calculi (renal and vesical), ten occurred in four families. Marcet mentions two brothers each of whom died with cystine calculi in their kidneys. Golding Bird speaks of an instance in which cystine was found in the urine in three successive generations (*see* Roberts and Dickinson).

Cystine is secreted as such by the kidneys. There is, however, some reason for considering the liver also as the source of cystine, and cystinuria as a sign of hepatic derangement; but, as Dickinson points out, “the clinical associations of cystinuria are too various to warrant any conclusive deductions on this head.”

Xanthine or uric oxide differs in composition from uric acid only in that it contains one atom less of oxygen. It has been found in the blood, in muscles, and in the liver, spleen, and brain; and Scherer states that in exceedingly minute quantity it is a natural constituent of healthy urine.

It has been found as a deposit in the urine, and it is pretty certainly of renal origin, and formed under the same clinical conditions as uric acid.

Nuclein, which is contained in many substances of an animal dietary, yields on decomposition phosphoric acid and various bases of the xanthine group; and uric acid is considered to be the ultimate product of the transformation of nuclein, which contains both sulphur and a considerable amount of phosphorus.

Dickinson thinks xanthine may be less rare than is generally supposed both as a calculus and as a urinary deposit, but that it is usually mistaken for uric acid. But the late Mr. Thomas Taylor, in describing the specimen of xanthine calculus which is in the Museum of the Royal College of Surgeons, said: "The close similarity in composition which exists between uric oxide and uric acid would lead to the conclusion that these substances might frequently be found mixed together in the same calculus. I have, however, submitted to careful examination several uric acid calculi which from their external characters might be supposed to contain xanthine, but hitherto without success."*

According to Roberts there have been but five xanthine calculi recorded, and none of these has been found in the kidney.

Indigo calculi.—Indigo has often been observed in the urine, but there are only two cases of indigo calculi on record, so far as I am aware (*see* pp. 45 and 46).

The ingestion of creasote or carbolic acid, the presence of pent-up pus within the body, peritonitis and obstruction of the intestines, are the conditions under which indigo appears in the urine. According to Senator many chronic affections accompanied by changes of nutrition lead to the increase of indican in the urine; and this substance when decomposed yields two substances, indigo blue and indigo red. Indigo blue is often seen in putrescent urines as a glistening blue film on the surface. Asiatic cholera and obstruction of the bowels of various kinds lead to the absorption and excretion of *indol*—a product of pancreatic digestion with a close affinity to indigo (Thudichum and Ord).

The means by which the precipitated particles are agglutinated into a renal calculus.—No calculus is formed without having in addition to its crystalline substance a colloid matrix. The colloid substance may be an abnormal ingredient in the urine, such as albumen, pus, or blood, or a substance normally present in urine, like mucus, or colouring or extractive matters. Ord, Roberts, and Ebstein † consider that the initial step in the formation of a calculus is the exudation of some colloid—mucus, albumen, blood, etc.—into the urinary passages. Dickinson, however, thinks it is not clear whether the crystals collect the web or the web the crystals, and that we are hardly justified in assigning to colloid substances so large a part in the genesis of calculi as Ord is disposed to do. He considers that primary calculi "are formed more in obedience to systemic states, and consequent variations in the normal constituents of the urine, than from local disease or 'colloid' admixture."

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* *Trans. Path. Soc.*, vol. xix., p. 276.

† Ebstein, *Semaine Médicale; Gazette Médicale de Paris*, Sept. 4, 1897.

The probable explanation is that the organic matter necessary to the formation of calculi is derived from the desquamation of and changes in the epithelium of the urinary tubules or renal pelvis, whether brought about by the irritation caused by the excess of uric acid or the urinary salts in the urine, or by the elimination of substances which are not found in the normal urine (xanthine), or by the presence of a foreign body such as a clot of blood or muco-pus, or the eggs of Bilharzia, or the micro-organisms to which Galippe has assigned so important a *rôle* in the formation of calculi.

The presence of a colloid would seem to be indispensable; when present, the uric acid or the urates or their salts may be cemented into a calculus which may go on increasing as long as the colloid is produced. When it is wanting the individual may discharge large quantities of uric acid or urinary salts, but no calculus will be formed.

Mr. Rainey (1858) thought the urine salts were drawn together and consolidated into a calculus by a process or force which he called molecular coalescence, a physical process which is to be distinguished from simple crystallisation; and this same author also studied the separation and dispersion of certain compound calculi under a process which he termed "molecular disintegration." Rainey's researches into the production of artificial calculi outside the body prove that stones are only formed under certain very definite conditions, which accounts for the fact that, although the composition of the urine in many people would seem favourable to stone formation, the actual conditions necessary for such formation are only present in the few.

The condition of colloids in the urine exercises a considerable influence upon stone formation, for it has been shown by Ord that the diffusion of colloids opposes the formation of calculus.*

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* For further information concerning the formation of calculi *see* (1) Rainey, "On the Mode of Formation of Shells, etc.," 1858; (2) Ord, "Microscopic Structure and Formation of Urinary Calculi"; (3) Harrison, *Clinical Journal*, 1893.

Pathology.—The morbid changes wrought upon the kidney by a renal calculus are either of an aseptic or septic nature.

Aseptic changes.—Aseptic changes may occur prior to the formation of a calculus and as the result of an irritation in the parenchyma or renal cavity caused by a pre-calculous yet calculous-predisposing condition. It has previously been stated that the excessive or abnormal elimination of uric acid or the urinary salts, or the elimination of substances not normally present in the urine, as well as the presence in the kidney of foreign subtances such as a small blood-clot the result of an injury, or the eggs of Bilharzia, can excite changes in and desquamation of the epithelium of the renal tubules, calyces, or pelvis. A true desquamative nephritis or slight catarrhal pyelo-nephritis is in fact commonly a forerunner of the formation of concretions—of the concreting of the urinary precipitates. The nephritis which starts in the epithelial changes soon results in interstitial sclerosis. But if every calculous kidney is in this way affected by nephritis, the changes in the parenchyma are generally only to be detected by microscopic examination, whilst the organ to the naked eye appears healthy. After a time, however, such a kidney may be increased in size, and Le Dentu observed in one case a true hypertrophy. Subsequently the kidney atrophies more or less, and has the look of an ordinary contracted kidney. Two different forms of atrophy are found—one in which the kidney is simply shrivelled as the later effect of nephritis, and the other in which the renal tissue is absorbed consequent upon the pressure of hydro-nephrotic distension.

If the calculus remains in the kidney and grows to a certain size until it more or less fills the renal pelvis, or if it interferes with the free escape of urine by falling like a ball valve into the upper end of the ureter, atrophy or hydro-nephrosis is superadded to the nephritis. In some cases the calculus extends its irritating effects beyond the true limits of the kidney, and thus, besides causing nephritis with hypertrophy or atrophy, there may be also considerable overgrowth and induration of the circumrenal fibro-fatty tissue, as there so often is round about the suppurating kidney (Fig. 117).

In rare cases, and rarer in the aseptic than in the suppurating cases, the whole kidney is converted into a lipomatous mass, with fibrous septa indicating the original medullary areas of the organ, and with the hilum filled with fibro-fatty tissue. There is in fact a substitution of fat for the whole of the kidney tissue (*see* Fig. 118).

General hydro-nephrosis, in which the whole kidney is distended and its parenchyma more or less atrophied, is a frequent result of a calculus lodged in the renal pelvis or in the ureter; but in certain cases a partial hydro-nephrosis is the result, as when a calculus obstructs only certain calyces, or only one ureter, in kidneys in which there are two ureters, the dilatation involving only the corresponding portion of the kidney.

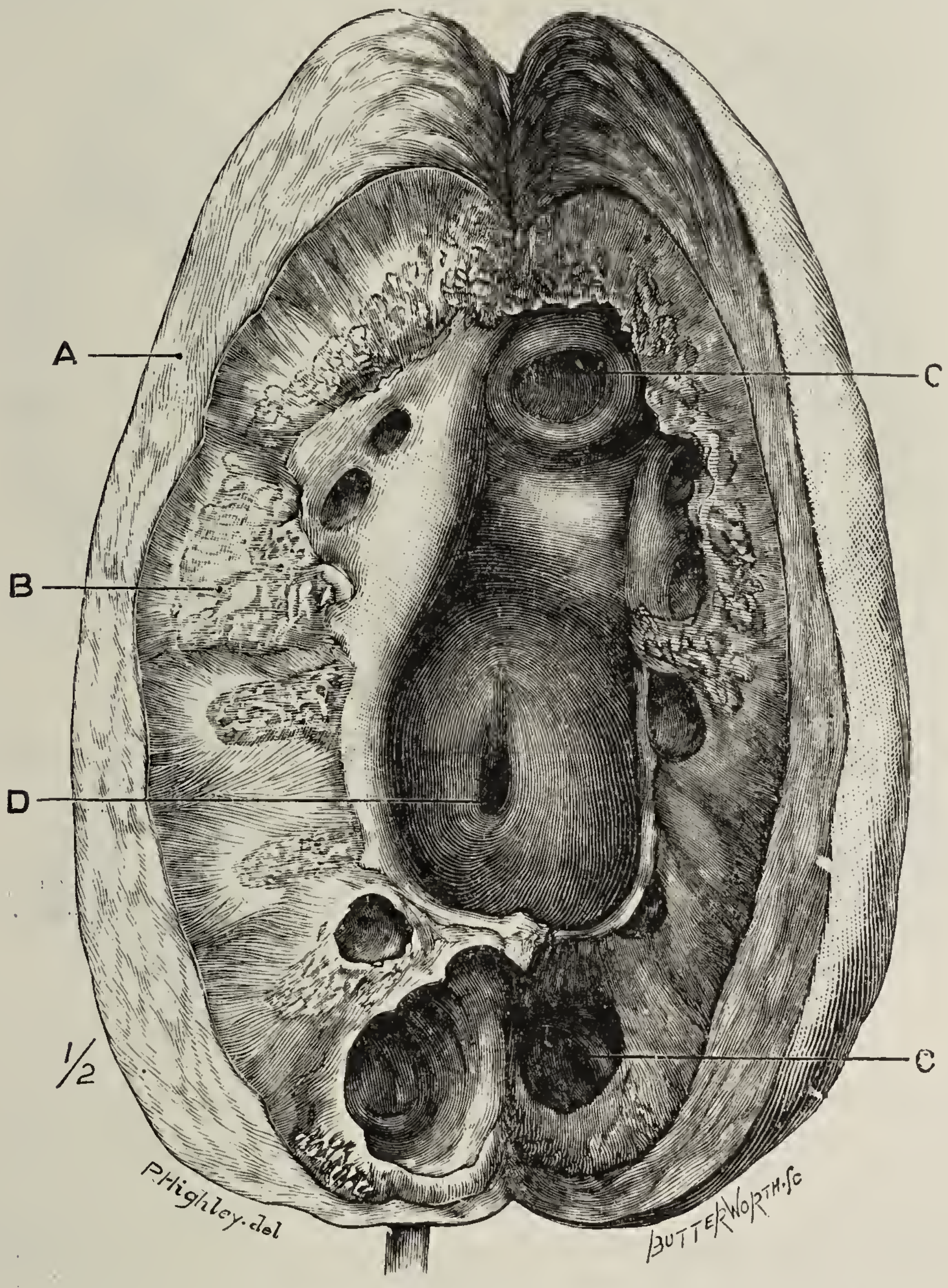

Fig. 117.—Kidney surrounded by thick fatty casing.

A, Fatty casing; B, kidney structure slightly breaking down; C C, cavities occupied by calculi; D, opening into ureter. (Middlesex Hospital Museum.)

In certain cases of horse-shoe kidney with two or more ureters a calculus has obstructed one ureter only, and has led to the distension of the corresponding portion of the kidney alone.

Septic changes.—The changes brought about in the kidney by the irritation caused by the elimination of uric acid or of the urinary salts in excess, as well as by the obstruction to the ready outflow of the urine, produce a condition of *locus resistentiæ minoris* favourable to the action of micro-organisms. The slight traumatism caused by the movements of the calculus, the renal retention, the desquamative and interstitial nephritis, and the vascular disturbances are means for preparing the way for the action of bacilli.

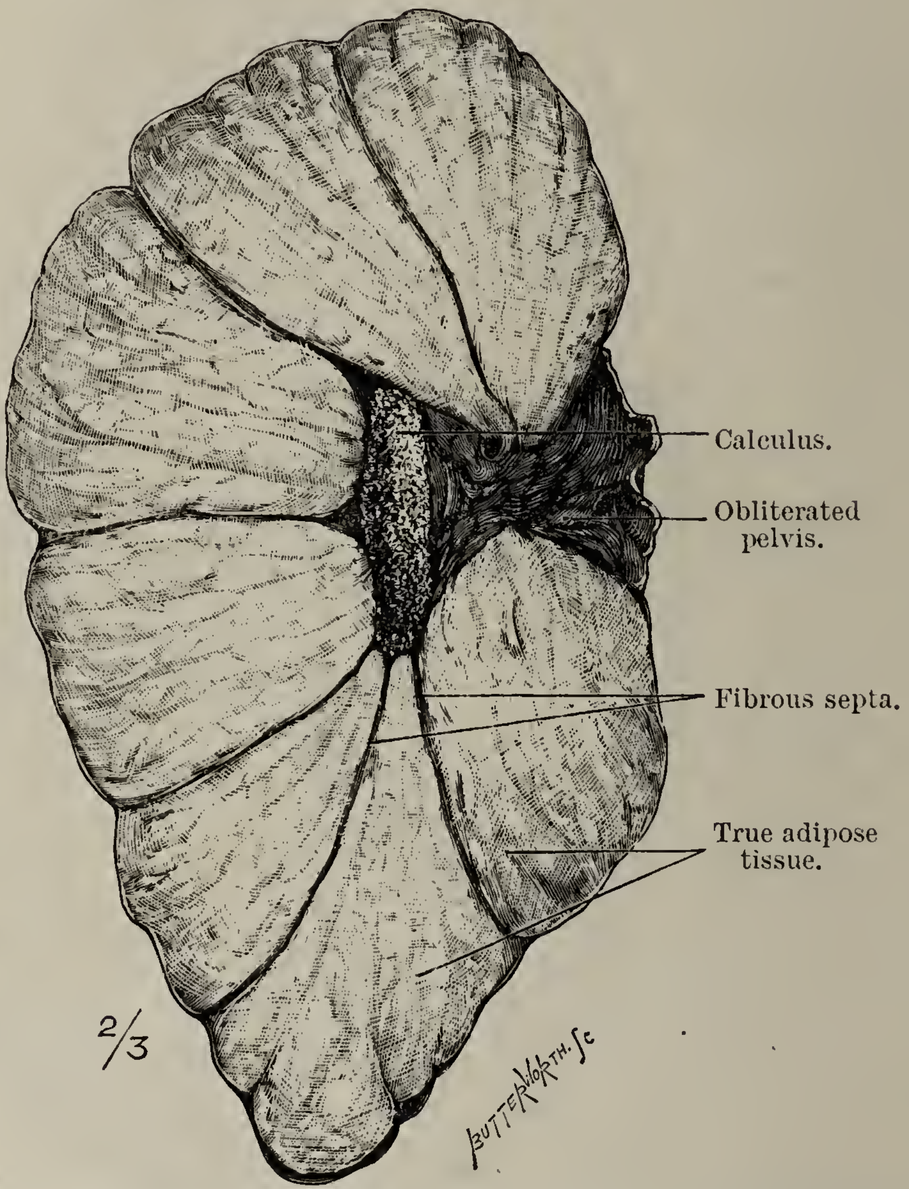

Fig. 118.—Fatty transformation of the Kidney. (From a paper by Dr. Edwin Richards in the *Brit. Med. Journ.* for July 7, 1883, on "Fatty Transformation of the Kidney.")

Secondary renal calculi are the result of infective processes in the kidney, set up either by disturbances within the kidney itself or spreading to the kidney from the lower urinary organs by a process of ascending infective uretero-pyelo-nephritis. But in the case of primary renal calculi the kidney previously prepared for their onslaught by the effect of the calculus may become the seat of infection either through the general circulation or through the lymphatics, or by means of the ascent of the micro-organisms along the ureter from the lower urinary organs.

The septic lesions of the kidney which result from the irritation of a calculus within the organ are the following: (1) suppurative pyelo-nephritis; (2) hydro-pyo-nephrosis; (3) pyonephrosis; (4) perinephritis and perinephric abscess; (5) external or internal fistula, the result of the bursting of a renal or circumrenal abscess in the loin, in the groin, or into the colon, stomach, pleura, or lung; (6) some concomitant lesions, such as carcinoma, sarcoma, or myxoma, which may be secondary to the calculus yet primary to the kidney, and may be set up by the continued irritation caused by the calculus;* (7) morbid changes in the opposite kidney, such as compensatory hypertrophy, or nephritis due to the elimination of uric acid or of urinary salts in excess, either simultaneously with or subsequently to the formation of the calculus in its fellow organ.

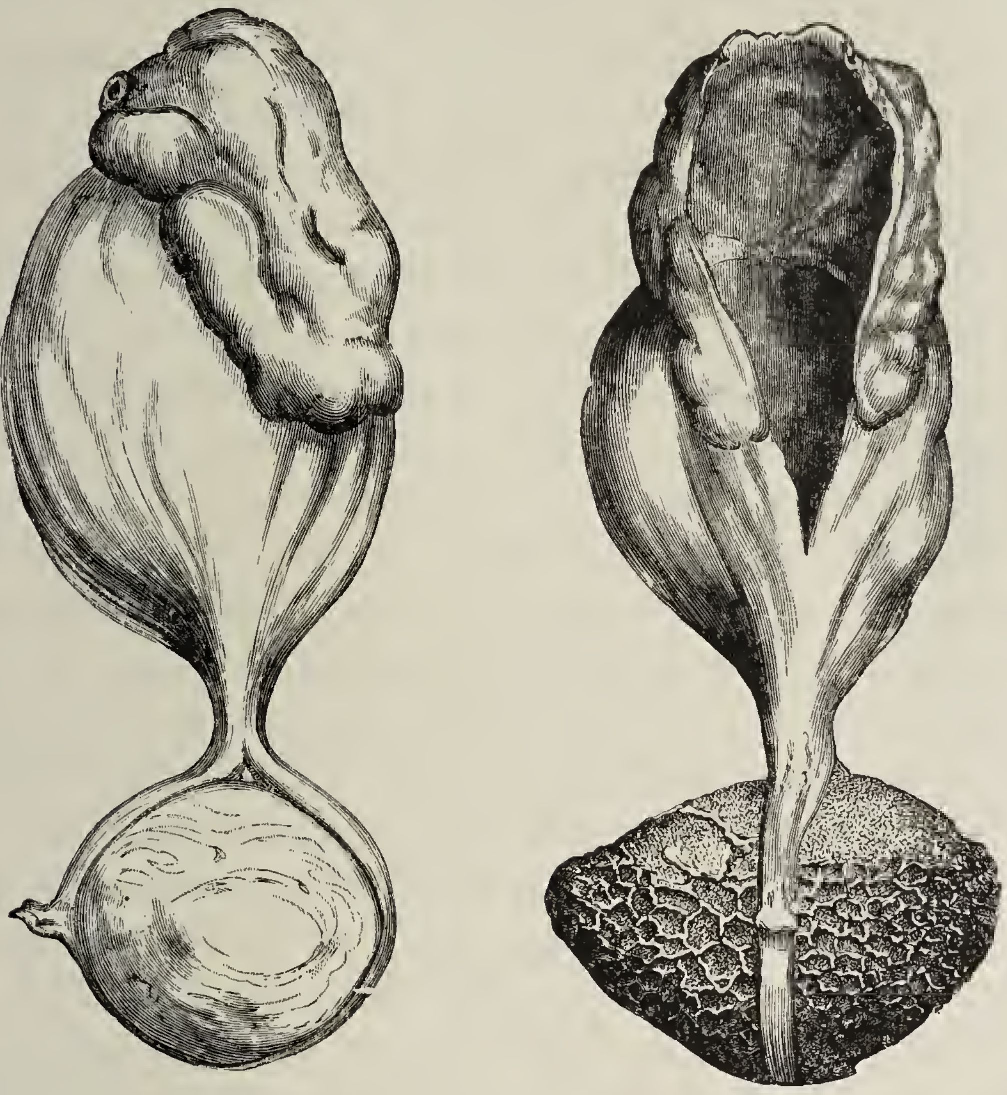

Fig. 119.—Two Views of the Pelvis of a right Kidney expanded into a Sac considerably larger than a turkey's egg. (St. George's Hospital Museum, No. 3911 ; 53B.)

The kidney is reduced in size and conspicuously lobulated. The calyces are dilated. An oxalate of lime calculus weighing 7½ ounces occupied the pelvis, and is represented in the figure as slung in the ureter. The ureter was healthy. The renal pelvis was tightly stretched over the calculus, but it would seem that the unevenness of the surface of the stone allowed the passage of urine.

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* *See* case by Bruce Clark, *Illustrated Medical News*, Sept. 29th, 1888, and others mentioned in the chapters on Tumours in this work.

Calculous pyelitis and pyo-nephrosis are caused by the obstruction to the outflow of urine, and by the presence of retained and decomposing urine.

When the obstruction is complete the kidney will atrophy, and the retained urine and pus may dry up into a putty-like concretion; or the kidney, having been converted into a large abscess cavity, may burst externally, or into the peritoneum, stomach, intestine, lung, or pleura. When the obstruction is incomplete—and it may be so though the stone is very large (*see* Fig. 119)—or intermittent, nephrectasis occurs, or lardaceous disease may be induced, or the patient may become worn out after months or years by continuous suppuration, and die of septic fever or exhaustion.

In some cases of pyo-nephrosis the kidney is converted into a series of chambers more or less completely shut off from one another, containing pus or purulent urine, or solid or semi-solid purulent creamy material, as well as calculi of different composition. Dr. Freyberger* records a case of double pyo-nephrosis caused by impaction of renal calculi in a woman aged thirty-seven, who had had no previous illness and had never passed any stone or gravel. She was seized with violent pain on December 31st, and died with symptoms of collapse on January 7th. The right kidney was converted into a bag with eight compartments, in seven of which there were irregular-shaped uric acid calculi, varying in size from a plum-stone to a large walnut—one large stone formed a complete cast of the renal pelvis. There was very little renal substance left, and that showed chronic parenchymatous and interstitial nephritis. The left kidney and ureter were dilated and contained pus and urine; and impacted in the left ureter near its insertion into the bladder was a small elongated stone the size of a date-kernel.

The primary calculus is coated with a quantity of carbonate of lime and of the mixed phosphates of lime, magnesium, and ammonium; and there will be present probably one or several secondary calculi composed entirely of these salts, which have become precipitated as the result of the septic lesions and the decomposition of urine induced by the primary calculus.

In addition to these changes within the suppurating or infected kidney there is frequently observed a very pronounced condensation of the perinephric fatty or fibro-fatty tissue, which becomes more or less toughly adherent to the fibrous capsule, and spreads through the hilum into the interior of the kidney. This condition is generally more marked in the suppurating than in the non-suppurating kidney (*see* Figs. 33 and 34, Vol. I., pp. 271 and 272).

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* *Trans. Path. Soc.*, vol. xlix., p. 171, 1898.

Pyo-nephrosis, like hydro-nephrosis, may be limited to one part of the organ and not be distributed throughout the whole; or the whole organ may be distended and sacculated, but in some parts urine, in others urine and pus, and in others thick pus may be the contents of the sacculi.

Cholesterine has been found in a case of calculous pyo-nephrosis. Murchison published an account of a case of double pyo-nephrosis in a man aged fifty-four. In the left kidney, which was very large and sacculated, an enormous concretion filled the renal pelvis, a large fragment of which was examined by the late Dr. Marcet. It had a snow-white appearance and was composed of glistening satiny scales like spermaceti, and on chemical examination was found to be composed of triple phosphate with a small quantity of phosphate of lime; but neither it nor the pus in this kidney contained cholesterine.

The right kidney, which was the larger and about the size of a child's head, contained many ounces of pus glistening with scales of cholesterine; the upper end of the right ureter was partially blocked by the lower end of a calculus one inch and a half long. The urine during the latter part of the man's life was known to contain very numerous crystalline scales of cholesterine as well as pus and blood, but no triple phosphate crystals or bile pigment. Murchison believed this to be a unique case, so far as concerns the passage of a large quantity of cholesterine in a crystalline form in the urine; though he refers to other observers who had remarked upon the presence in the urine of cholesterine, but not in a crystalline form.*

In the section on hydro-nephrosis (Vol. I., p. 398 *et seq.*), reference has been made to cases in which cholesterine in crystals was present in the hydro-nephrotic fluid (*see* also *post*, p. 94).

Changes around the kidney.—Calculi in some rare cases escape from the kidney into the tissue surrounding the organ, after setting up a renal abscess which bursts into the perinephric tissue. In some of these cases the calculi have subsequently escaped spontaneously through fistulous openings in the loin or groin, or have been found and removed on opening a perinephric abscess or subsequently when tracking and laying open a purulent fistula.

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* *Trans. Path. Soc.*, vol. xix. p. 280.

An illustrative case by Weekes will be found in the *Boston Medical Journal*, 1894, p. 169, and another by the author in "Hunterian Lectures," p. 84.

A case was recorded by the late Dr. Pearson Irvine* in which an aneurysm of the cæliac axis is attributed to diffuse suppuration around the left kidney and in the retro-peritoneal tissue consequent on renal calculi. The pelvis of the left kidney was distended and the ureter dilated, due to a calculus which partially blocked the tube lower down. There was great hypertrophy of the perinephric adipose tissue which had invaded the kidney.

Besides the several consequences above enumerated, another must not be omitted, namely *suppression of urine*. This may arise from calculus in the pelvis of each kidney or in the pelvis of one kidney and in some point of the ureter of the other. The kidneys may thus be simultaneously or successively disabled, more frequently successively, one kidney having been rendered useless before the other is at all incapacitated.

Dickinson points out the not unfrequent association between renal calculous disorders and epilepsy and insanity.

The effects of migratory calculi.—These stones may make their way along the ureter to the bladder without causing any trouble; but, on the other hand, after passing down a longer or shorter distance they may become impacted and then cause very serious and even fatal consequences. Agonising colic persisting over many days, followed by suppuration, ulceration of the ureter, and extravasation of urine into the cellular tissue, or by perforation of the intestine or peritoneum—these are some of the results of failure of the stone to reach the bladder.

In some cases even very small calculi, having once entered the ureter, cannot pass along it, but become fixed in the ureteral wall and either lead to permanent occlusion by the fibrous changes which follow upon ureteritis and peri-ureteritis, or else to some of the destructive changes just mentioned.

Symptoms. — A small stone may develop, travel along the urinary passages, and escape without giving rise to any symptom. A stone of moderate or even large size may remain in the kidney for years without causing any noticeable symptoms whatever, and having been uncomplained of during life may be met with as a surprise when the body is examined after death.

I shall point out further on that there are numerous morbid conditions other than renal calculus which cause typical renla colic. Conversely, there are many cases in which the symptoms due to renal or ureteral calculus are not referred to the kidney or ureter at all, but to some other organ; and in these cases a calculus may remain quite unsuspected.

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* *Trans. Path. Soc.*, vol. xxix., p. 85.

Unsuspected calculi group themselves into three classes:—

A. Calculi which cause no symptoms.

B. Calculi which cause symptoms that are not referred to the kidney or ureter.

C. Calculi which cause high temperature and great psychical disturbance, but indefinite (if any) renal or urinary symptoms.

A. *Calculi which do not cause symptoms.*—I might quote several cases in which a calculus, after existing for years, has set up perinephric abscess without having previously caused any definite renal symptoms. A typical case of the kind is recorded on pp. 220 and 221 of "Surgical Diseases of the Kidney" (1885), and the calculus is illustrated in Fig. 29 (Vol. I., p. 163) of this work.

I have met with cases in which a calculus has grown silently to such a size as to be felt on palpating the abdomen without causing any subjective symptoms. Bruce Clarke has recorded that in thirteen out of twenty-four post-mortem cases of renal calculus there had been no symptoms during life. Murray of Capetown, Noble of Philadelphia, and others, and quite recently Doran of London, have published cases of painless pyo-nephrosis and long-standing renal calculi, which have caused no symptoms.

B. *Unsuspected calculi with symptoms transferred to other organs.*—With renal calculus, as with vesical calculus or hip joint and spinal diseases, pain may be transferred to a distant part instead of being felt in the organ affected. The symptoms may be referred to the bladder, ovary, uterus, or testicle, instead of to the kidney.

Cases of renal calculus and other renal diseases are often erroneously subjected to prolonged and repeated treatment for cystitis. Bladders are frequently sounded, irrigated, injected with solutions of silver nitrate, and otherwise actively treated, without apparently the least suspicion that the trouble is due to stone in the kidney. In one very striking instance in which for nearly ten years a vesico-vaginal fistula was maintained, the symptoms pointed entirely to the bladder, not at all to the kidney; but at length a renal calculus was removed, and then the vesico-vaginal fistula was closed without any return of the symptoms which had necessitated it, and the patient regained perfect health. It is sometimes the same with the ovary as with the bladder; it receives all the attention and treatment, whilst the cause of the trouble is in the kidney. I altogether exclude in these remarks cases in which there is some morbid organic or functional state of the ovary as well as of the kidney. I refer exclusively to instances in which pain, either paroxysmal or constant, is referred to the healthy ovary, not to the kidney, and may be associated with tenderness in the hypogastrium or in the vagina, and yet is caused by renal calculus or gravel.

Abscess or stone in the kidney may give rise to symptoms which are erroneously ascribed to misplaced or deflected uterus. I have erased parts of the kidney of a lady of thirty years of age for two small abscesses, in each of which there was a small calculous mass. Yet this patient had been treated for eight years for misplaced uterus, and had worn pessaries during that time. Her symptoms entirely disappeared after the operation on the kidney. The uterus was quite normal in every respect.

Franks refers to a woman who is said to have had both ovaries removed before her troubles were finally dissipated by the extraction of a stone from her kidney.

C. *Unsuspected calculi with high temperature and great psychical disturbance.*—Another group of cases is that in which the patients are desperately ill with symptoms of a typhoid type attended with acute but vague pains over the whole body and with great mental prostration, but with none of the ordinary symptoms of stone. I have recorded a striking case in which the illness terminated after the discharge from the kidney of a few ounces of pus and some renal calculi.*

There are other cases in which marked nervous symptoms are present, but without high fever or any of the ordinary symptoms of renal calculus.

QUIESCENT CALCULUS.—There are cases in which a renal calculus, after exciting symptoms such as lumbar pain, hæmaturia, or pyuria, becomes quite quiescent for long periods: all symptoms entirely disappear, and the bearer of the calculus may go through five, ten, or twenty years, leading a most laborious life, without any reason for supposing that he has that within one of his kidneys which at any moment may become a sudden danger not only to the integrity of the organ but to life itself.

* "Hunterian Lectures," p. 66.

We must not be unmindful of the possibility of pyo-nephrosis, renal abscess, or calculous anuria being quickly lighted up by a hitherto quiescent calculus, or by one giving only slight and occasional reminders of its existence.

In the greater number of cases, however, there are some symptoms indicating the presence of a stone in the kidney, such as one or more attacks of renal colic; some lumbar, abdominal, or inguinal pain aggravated by exercise and by any jarring or jolting movement; some blood or albumen mixed with the urine; some vesical irritability; perhaps some pain in the testicle of the same side; or hæmaturia. If blood is not invariably present (and in many cases it is not), it may occur from time to time in large amount, making the water bright red or porter-like in colour for several days together. If the stone has existed a long while, albumen or pus will be found daily in a minute or moderate or marked quantity in the urine. With these symptoms the patient in some cases occasionally passes gravel or minute calculi or fragments of calculous matter.

In 103 cases of renal calculi, the prominent symptoms of which were sufficiently given, I found hæmaturia in forty-one, pain in seventy-one, renal colic in forty-four, pyuria in fifty-nine, lumbar tumour in twenty-seven, troubles of micturition in twenty-four, and tenderness over the kidney in seventeen. Urinary crystals were specified in twenty cases out of sixty-five in which there was mention of them.

Renal colic.—A calculus either may remain fixed in the kidney substance or in a calyx, or may occupy the renal pelvis, within which it can move about, or it may migrate along the ureter towards the bladder. In either of the latter conditions it will probably give rise to renal colic.

A calculus traverses the ureter partly by the weight of the accumulating urine behind, partly by the vermicular contraction of the muscular coat of the ureter, aided too, perhaps, by the retching and vomiting which its transit excites. As soon as a stone enters the ureter, or is being propelled along it, stretching it as it goes, renal colic sets in. The attacks of renal colic come on suddenly, last for two or three hours or as many days, and almost as suddenly subside, to recur at some future period, if the stone, instead of escaping at the lower end of the ureter, is simply displaced from the upper orifice into some less important point in the renal pelvis. Recurring attacks of colic arise from fresh formation of renal calculus. A gentleman under my observation many years ago had three distinct and severe attacks of colic, lasting about three days each, and coming on at almost time-regulated intervals of six months. From thirty-six to forty-eight hours after each attack a small, irregularly rounded, smooth-surfaced calculus was voided with the urine. He was placed upon a regulated diet, and ordered soda-water with bicarbonate of soda added to it as a daily drink, and when seen only a few months ago he stated that he had had no attack since he began the treatment. Such periodic formation and discharge of renal calculi are not so very uncommon.

Sometimes a fragment of a large calculus passing along the ureter excites renal colic, and complete relief does not follow its discharge from the body; or a small calculus in its transit causes the colic, and a second or third calculus remains behind to still trouble the patient.

Periodic attacks of renal colic occur in some cases without being followed by the discharge of a calculus or fragment of a calculus. They are then due to the irritation of a calculus in the pelvis or one of the calyces of the kidney under the influence of movement of a jolting or shaking character, such as running, dancing, riding in a carriage, or travelling by sea; or to the passage of a lump of muco-pus or blood-clot along the ureter. They will also come on without any ascertainable cause, especially when the patient falls into low health or is worn out by prolonged or fatiguing occupation.

During these attacks the pain, which is intense or even agonising, shoots down the course of the branches of the lumbar plexus, and is felt in the bladder, in the groin, along the thigh, or in the testicle. The pain is paroxysmal, and intensified by the spasmodic contractions of the ureter; it causes the patient to groan and scream in torture, and to assume varied contorted positions and movements. The testicle may be retracted at the time, and afterwards become enlarged and remain for a long while tender, if not painful. I have seen the testis of the affected side small and wasted as well as retracted. Women have aborted, men have committed suicide, and both men and women as well as children have been thrown into convulsions during the fearful agony of renal colic. The attack is often ushered in with a rigor, and is generally accompanied by vomiting, retching, and profuse perspiration. Faintness and collapse are by no means rare. The bladder is irritable, and the urine, which is diminished in quantity during the attack, is blood-stained and loaded with urates, and is sometimes passed with a good deal of scalding in the urethra. The hæmaturia is usually most severe in cases of calcium oxalate calculus. Occasionally it happens that the other kidney secretes freely during the attack, and if so the urine will not be diminished in quantity and will not be thick.

The end of the attack is frequently as sudden and abrupt as its onset, or even more so; a sense of immediate relief is experienced by the stone entering the bladder. From the bladder it may be ejected almost at once, or not for many hours or for three or four days after entering that viscus; or the stone may remain in the bladder or become impacted in some part of the urethra.

Pain.—Apart from the attacks of renal colic, one of the commonest symptoms due to the continued presence of a stone in the kidney is renal pain. This pain is referred to the loin, to the front of the abdomen over the side corresponding to the affected organ, or along the course of the ureter to the groin. A small calculus may give rise to such a localised sensation as to create in the mind of the patient a clear impression of the size and outline and exact position of the offending body.

Owing to the wide nerve connections of the kidney, the pain of renal calculus is often transferred to a distance, *e.g.* to the testis or labium, along the spermatic plexus and the genito-crural nerve; to the upper part of the thigh by the genito-crural; to the leg and the inside of the foot through the anterior crural. Dickinson and Ralfe each speak of cases of pain in the sole of the foot. One patient had the sensation "as if the sole were raw, and being rubbed with scouring paper." In another the pain was continuously either in one of the heels or in the sole of the foot, or more rarely in the outer edge of the foot. Pains in the sole and outer side of the foot are less directly explained.

The intensity and character of the pain of renal calculus vary greatly in different persons. It may be of any degree of intensity, from a mere aching to an acute lancinating or stabbing nature. It is of every variety. It is sometimes described as a gnawing pain, sometimes as a pricking pain, at others it is spoken of as a sense of weight, dragging, boring, or compression. It is very commonly spontaneous; but is frequently provoked by movement, by prolonged standing, and by shaking or jolting; and it is as commonly relieved by rest and the recumbent position.

Movements, such as carriage exercise, running, or walking, are not in all cases needed to cause exacerbation of the lumbar pain; on merely turning in bed, or even when lying asleep, the patient may be aroused by a sudden agonising seizure. It is often aggravated by the menstrual function.

It would thus seem that the varying pressure of the abdominal viscera, the passage of fæces along the colon, the variations in the degree of intrarenal blood pressure, are all capable of exciting pain by making the renal tissue press against the calculus. This is the more frequent when the surface of the calculus is rough and acicular.

Jordan Lloyd has drawn prominent attention to a "*stabbing pain*" experienced by the patient on making a sudden deep pressure with the finger on the loin in the direction of the kidney. It is of help when present, but unfortunately it is far from being commonly elicited.

Prout states, and Dickinson agrees with him, that uric acid calculus produces the least pain, and that of a dull oppressive character with a sense of weight; oxalate of lime causes a more acute kind of pain referred to a particular spot, as well as shooting to the ureter, shoulder, or epigastrium; and phosphates give rise to great and unremitting pain attended with exacerbations.

Various reflex pains have been described. Guyon and Thornton have laid stress upon a *reno-renal* reflex pain, *i.e.* a pain caused in one kidney by the presence of a calculus in the other; and a few cases have been recorded by surgeons which at first sight seem to support this teaching.

It is important to know that a stone in one kidney will sometimes excite sympathetic pain and irritation in the other; but this transferred or sympathetic pain is of an aching character, not of a spasmodic or colicky description, is only occasional, and never occurs except as an accompaniment of more severe pain on the affected side.

So far as my own experience and researches go, there is not a single case which affords satisfactory evidence of symptoms on one side only being caused by a stone in the kidney of the other side. The presence of a stone in the painless kidney is not proof that the painful opposite organ is not also affected. That the attacks on the painful side have ceased after removing a calculus from the painless kidney is not conclusive: this may be nothing more than a coincidence, due either to the accidental shifting of a calculus in the painful kidney, or to the calculus becoming lodged in some immovable manner.* There may be very advanced disease of the kidney on the painful side, and a symptomless calculus in the opposite kidney. In a case which has been under my care of late there was a sarcomatous growth in the right kidney with hæmaturia, but an entire absence of pain and tumour on the right side, throughout the whole course of the disease; yet intense pain was experienced in the left renal region radiating over the left side only. The inference would have been that this was a typical case of reno-renal reflex pain had not symptoms during the last few weeks of life and a post-mortem examination shown that the left-sided pain was due to a similar new growth involving the left transverse processes and the left side of the bodies of the lower dorsal vertebræ. I consider the doctrine of reno-renal reflex with an absence of pain in the affected kidney as unproved and unsound, and if acted upon in practice likely to lead to very serious and dangerous results, as I have endeavoured to show in my "Hunterian Lectures."

Reno-vesical reflex symptoms are not at all uncommon, and, as previously stated, in some cases are the only symptoms complained of: pain in the hypogastrium and in the neck of the bladder, and frequent and painful micturition, sometimes almost amounting to incontinence of urine, have been known to be the result of renal calculus when the bladder itself has been quite healthy. Pain in the bladder, with urgent desire to pass water, but inability to do so, is frequently complained of during an attack of renal colic.

The anatomical connections of the kidney with the bladder are much more important and direct than those of the two kidneys with one another. The half of the bladder may be regarded as an anatomical expansion of the lower end of the renal duct of the same side—the nerves, blood-vessels, and visceral coats of the ureter and bladder being in direct continuity—so that any irritation due to a cause seated in the kidney may thus be conveyed directly to the bladder.

Reno-ovarian and reno-uterine reflex.—It is somewhat the same with the ovary, Fallopian tube, and uterus: their connections with the kidney of the same side are more intimate than those of the two kidneys. The blood-vessels, and the nerves conveyed along them, of the ovary, Fallopian tube, and the uterus, are in close relation with the ureter of the same side. Moreover, the ureter has a considerable course within the folds of the broad ligament, and any drag or tension on the cellular tissue of the ligament is calculated to irritate the ureter, and any affection of the pelvic portion of the ureter to irritate the uterus and its appendages.

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* *See* "Hunterian Lectures," pp. 54–57.

Reno-testicular pain in a few cases overshadows all other symptoms, as in the case recorded by Mr. Butlin* in which severe neuralgia of the right testis existed for some time before lumbar pain or tenderness was noticed. The patient was quite cured after the removal of a small rough-surfaced oxalate of lime calculus from the pelvis of the right kidney.

Paroxysmal lumbar and sciatic pains, accompanied or not by retching, are by no means rare. Sometimes the sciatica is severe and continued, and though the pain will be on the side of the calculous kidney, there may be nothing to indicate the cause of the pain. In all such cases it is prudent to institute repeated examinations of the urine as to the presence in it of blood, albumen, or crystals; and a careful review of the clinical history, especially as to previous attacks of hæmaturia. At the same time it must be remembered that oxalic acid and uric acid in excess in the urine are often attended by hæmaturia, crystals in the urine, and wandering, transferred, and paroxysmal pains in the back, thigh, calf of leg, and sole of foot.

Gastro-intestinal symptoms.—Another symptom which results from transference of nerve influence has reference to the stomach: nausea, vomiting, and dyspepsia are very common, not only at the times of actual colic or the descent of a calculus, but during the periods of less acute suffering and whilst a stone is forming in the kidney or its pelvis.† These symptoms are explained through the connection of the pneumo-gastric nerve with the renal plexus. Godlee in the *Practitioner* (vol. xxxix., p. 246) points out that repeated attacks of intestinal colic accompanied by vomiting and nausea may be the only symptoms complained of in renal calculus, and should therefore lead to the careful examination of the urine. The retraction of the testicle, irritability of the bladder, pain referred to the thorax (sometimes thought to be due to pleurisy), are all explained in the same manner as the gastric disturbance and the pains in the lower limb, namely, by transference of nerve influence.

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* *Clin. Soc. Trans.*, vol. xv., p. 113.

† Jacobson, *Clin. Soc. Trans.*, vol. xxii., p. 212.

The renal pain, and the other common symptoms of renal calculus, are largely mechanical, and due to the actual contact of the stone with the mucous membrane of the kidney or ureter.

Hæmaturia.—The hæmaturia is not often profuse, and to the naked eye is far from being constant; but it is one of the most frequent symptoms of calculus, and microscopic traces are well-nigh invariable at some period or other. Occasionally it is profuse. Sometimes it is only sufficient to give a coloured deposit on standing, at others it needs a microscope for its detection. It is not proportionate to the size or number, nor dependent on the chemical nature of the stones, except in so far as the oxalate has generally the roughest surface and is therefore the most irritating. It is not invariably and intimately related to pain or to any of the other symptoms. In some cases it stands alone, in others it is associated with some of or all the other common indications of stone. It may precede, accompany, or follow renal colic; in many cases the hæmaturia is induced in the same mechanical manner as the pain, and therefore comes on with an attack of colic, though it often continues after the pain has ceased. Thus, if the colic lasts from three to six hours the hæmaturia may not cease for a day and a half, two days, or more. The hæmaturia is probably sometimes due to congestion rather than to traumatism: hence its occurrence during periods of rest; but this is not the rule. When there is a tendency to hæmaturia it is generally increased by exercise and movement, and stayed by rest. In the young woman upon whom I performed the first operation of nephro-lithotomy, and from whose kidney I removed a stone weighing thirty-three grains, profuse hæmaturia was a very prominent symptom, and like the pain, which also was severe, it was aggravated by walking and standing; but rapidly disappeared when the patient remained entirely in bed.

In another case, that of a young lady with a minute oxalate of lime calculus in her kidney, which later became impacted in the ureter, large quantities of blood were lost on the slightest effort to walk. On more than one occasion the hæmorrhage induced by slight movement was so profuse and persisting, and the pain so agonising, that a fatal result was anticipated.

In many cases in which there has been throughout no marked naked-eye hæmaturia, blood corpuscles have been frequently or almost invariably detected with the microscope. If very regular examinations are made of the centrifugalised deposit, it will often be found that the urine secreted and passed during the day contains a greater number of blood-discs than that secreted during the rest and quietude of night.

The constant presence of even a few blood corpuscles in the urinary sediment is, as a matter of diagnosis, as important as or even more important than pronounced intermittent hæmaturia.

Hæmorrhagic casts of the renal tubules are met with but very rarely; still less frequently, elongated decolorised worm-like clots, casts of part of the length of the ureter, are passed. The irregularly shaped clots which are formed in the calyces and renal pelvis are less rare in renal malignant new growths than in renal calculus. It must be remembered that hæmaturia occurs in many renal conditions other than calculus, as well as in a large number of cases in which uric acid, the urates, and the oxalates occur only as crystals in the urine.

Pyuria.—In many cases of renal calculus there are traces of pus, often only microscopic, but often even evident to the naked eye, due to a slight degree of pyelitis unattended with any fever or other constitutional signs. The condition is quite mild and chronic, and the patients lead their ordinary lives as unconscious of there being anything wrong with the urine as they are when microscopic traces only of blood occur in their water. This symptom, like the pain and hæmaturia, is an effect of the slight traumatic lesions caused by the calculus in the renal pelvis, and by no means indicates that an infection has travelled upwards from the lower tract. Sometimes, as the first sign of pyelitis, before pus corpuscles are seen, the microscope reveals granular corpuscles and epithelial cells or scales mixed in fibrous threads of mucus, as well as a few blood corpuscles. Mucus and the fibrous threads of mucus occur more frequently when the calculus is of oxalate of lime. The pus of pyelitis occurs in acid urine, is not stringy, and separates readily from the urine on standing. The urine is not offensive. When, as in some advanced cases of primary calculus, the urine is rendered offensive by having undergone decomposition in the pelvis of the kidney, the destruction of the kidney is considerable, and the health of the patient materially affected (*see* the chapter on Pyelo-nephritis, Vol. I., p. 303, and the section on Pyo-nephrosis, Vol. I., p. 444).

In some rare cases a cast of the ureter consisting of mucus with pus-cells embedded in it has been passed. A case of the kind is published by Andrew J. M'Cosh in the *New York Medical Journal* (April 14, 1888, p. 406) in which the urine was carefully examined daily for eight days, and was found to contain many epithelial cells, but no pus, blood, albumen, or crystals of any kind. On the ninth day the muco-purulent cast of the ureter was voided, and from that date onwards to the operation the urine contained pus in considerable amount, and also a few blood corpuscles.

Chemical and microscopical examination of the urine. — A careful examination of the urine ought to be made in every case of renal calculus or suspected calculus. It is important to ascertain the presence or otherwise of albumen, of microscopic quantities of blood, of leucocytes, and traces of pus, of crystals, or of casts of renal tubules. Sometimes the microscope leads to the unexpected discovery of the eggs of the Bilharzia. Careful search is also frequently needed for the bacilli of tubercle.

Hyaline casts are present in a large number of cases of renal calculus, and their presence, indicating as they do renal irritation, together with other symptoms of renal calculus, is of great diagnostic importance.

Traces of albumen are almost constant, and if not in excess of the blood or pus do not imply the existence of nephritis. Nor does the presence of albumen and hyaline casts contra-indicate operative treatment.

The specific gravity of the urine is of importance, especially when taken in conjunction with the daily quantity excreted. A normal specific gravity, with a normal amount of urine, shows that the output of urea is satisfactory and that chronic nephritis is not present to any advanced degree. It also excludes many neurasthenic conditions, and possibly, too, renal tuberculosis.

Physical examination of the kidney and ureter.—When the patient is very thin, and the stone large, it can sometimes be detected on palpation. Howship speaks of a patient who used to feel the stones in her kidney grating together on movement. Pick published in the *Lancet* a case in which he made the calculi grate upon each other by bimanual pressure with his hands placed on the loin and the front of the abdomen; similar cases are on record. I have recorded some such in my "Hunterian Lectures," and in not a few others I have been able clearly to make out the presence of calculi, either by rubbing them against one another or by their hardness and outline as felt through the abdominal parietes.

Tenderness over the affected kidney will often be complained of when pressing on the loin or over the front surface of the organ. If with the fingers of the left hand, placed immediately below the last rib in the loin, the parietes in the ilio-costal space are pushed well forward, and the fingers of the right hand are depressed deeply below the costal margin in front, whilst the patient (in the recumbent position) makes a forced expiration after a deep inspiration, the kidney will be compressed between the two hands of the surgeon, and tenderness, sometimes an acute pricking pain, is often experienced by the patient. Though this bimanual pressure must be considerable to be effective, yet the difference in the sensation given to the patient by its application over the calculous as compared with the non-calculous kidney is generally very marked. I have never known pressure over a calculous kidney give rise to pain over the opposite kidney; and certainly not to pain only on the side not under examination, as Guyon and Albarran have observed.

Another indication of some value is a marked difference in the degree of hardness of the muscles of the abdominal parietes over the two kidneys. I have often found the tension and resistance on the affected side great, whilst over the unaffected organ the parietes have been soft and supple, yielding readily to pressure.

The peculiar attitude and gait sometimes assumed by a patient with a renal calculus are due to an effort to relax as much as possible the abdominal walls, and especially the great psoas muscle, so as to remove all pressure on the kidney. Thus, as in perinephric abscess, hydro-nephrosis, and other renal affections, lateral inclination of the trunk and flexion of the thigh are usual.

Tenderness and pain along the course of the ureter.—It is not easy, and it is sometimes impossible to judge from the actual point to which the patient refers his pain, whether a calculus (supposing one to be present) is in the kidney substance, the renal pelvis, or the ureter. With a calculus in the kidney, the only or the greatest suffering may be referred to the middle of the ureter; or with a stone in the ureter, the reference as to pain may be made to the kidney itself.

When a calculus has migrated the length of the ureter, a dull pain or an aching may be felt along the course of the duct for several days afterwards. I have known it continue in one case for nearly a fortnight.

Cystoscopic examination and the introduction of the ureteral catheter and ureteral sound may be of some assistance in exceptional cases: (1) A difference in the state of the ureteral orifices or of the character of the urine which is escaping from them—*e.g.* œdema of one ureteral orifice, or the presence of pus or blood in the urine from one ureter, and not in that from the other—would serve in cases of doubt to point to the diseased organ; (2) the passage of a ureteral bougie tipped with wax or porcelain might serve to show the presence of a calculus or calculous material in the ureter (Howard Kelly). It is only, however, in very exceptional cases that these methods, difficult of application in the male, not altogether free from danger and not always to be relied upon as to results, will need to be employed.

There is much truth in the remark of Dr. J. H. Musser of Philadelphia, who in a short paper on "Renal Calculus" (April, 1898) said with reference to catheterisation and exploration of the ureter in the diagnosis of renal calculus: "I must confess I am more in sympathy with Holländer than with Casper in the tenets he upholds. These doughty opponents have been stating their views in the recent numbers of the *Berliner klinische Wochenschrift.* I feel with Holländer, we can in a large number of cases make a diagnosis without the aid of catheterisation, and I appreciate with him the danger of infection from below—of which he cites cases. It is worthy of remark that the only cases of pyelitis in my own private practice were from this source."

Radiography.—Hopes were entertained that the Röntgen rays would be of service in determining the presence or absence of renal and ureteral calculi, but hitherto they have afforded but little reliable help in this direction.

MacIntyre, Morton, C. Lester Leonard, Swain of Clifton, Mackenzie Davidson, R. Abbe,* and several others have succeeded by this means in correctly demonstrating the presence of renal calculi in the living body. Leonard goes so far as to state that the presence or absence of all calculi can be fully established;

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* Morton (*Lancet*, June 4th, 1898); James Swain (*Bristol Med.-Chir. Soc.*, 1897); MacIntyre, Glasgow (*Lancet*, July 11th, 1896); Robert Abbe (*Annals of Surgery*, August, 1899).

that such definition and detail are possible that an absolute positive and negative diagnosis can be secured in all cases, the outline of the kidney itself being demonstrated in the negative cases. The screen has been more successful than the photographic plate, and Mackenzie Davidson by means of the screen has admirably succeeded in precisely indicating the exact part of the kidney occupied by a calculus. The screen gives far more delicate results than a photographic plate, and a negative result with a plate goes for nothing in the presence of clinical signs indicative of calculus. But I wish specially to point out that what may seem to be positive results with the plate are also unreliable. I have been called upon to operate in three or four cases in which from the shadow shown by the plate there has been the strongest belief on the part of the photographers and of those who have called me into consultation that a stone was present. An exploration was made, and the absence of a calculus either in the kidney or the ureter was proved. In a quite recent case a radiogram taken by one of the best experts in London seemed to show a single calculus in the lower pole of the kidney. I removed two calculi from the upper end of the same organ which were not indicated in the plate or on the screen, but there was no stone in any other part of the kidney. Guyon, Tuffier, Albarran, and other surgeons agree as to the uncertainty of the method in the diagnosis of renal calculus.

The whole length of the ureter as well as the kidney require to be tested, because a stone in the ureter will cause symptoms entirely referred to the kidney.

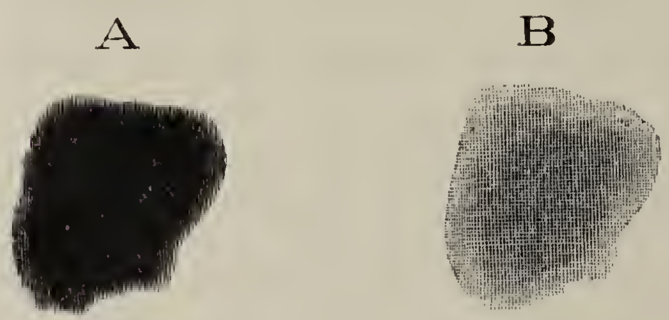

Fig. 120.—Photographs of Stone by X Rays.

A, Four minutes' exposure; B, eighteen minutes' exposure.

Something of this uncertainty is due to the varieties of character of renal calculi. In the *Lancet* of November 14th, 1896, I described and profusely illustrated the effects of the X rays upon biliary and different kinds of renal stones photographed out of the body. I discussed the main factors which govern the depth of shadow cast by the calculi, and showed that oxalate of lime calculi throw even deeper shadows than bone: that phosphate of lime calculi, and mixed calculi composed of a nucleus of uric acid and alternate layers of fusible calculus and uric acid, also give dark shadows, but that a pure uric acid calculus gives only a faint shadow, about equal to that yielded by biliary calculi, and little deeper than the normal kidney tissue itself. I also pointed out that the opacity of bone is due to the calcium salts, and proved the point by exposing a piece of decalcified rib with a normal piece upon the same plate. The former threw scarcely a trace of shadow. Figure 120 also shows the effect of over-exposure, and how faint the shadow may become by a prolonged action of the rays. Lester Leonard, in his most recent paper, insists upon this last point, and adds: "The greatest value of the Röntgen ray in physical diagnosis is not in penetrating all tissues, but in producing differentiations between tissues that will lead to logical conclusions and absolute diagnosis. Thus in examining for calculi we do not want rays that will penetrate all tissues; we want a differentiation in the shadows that will demonstrate beyond a doubt that all calculi, no matter what their relative density, would cast shadows if present in the field examined. Such definition and differentiation make the negative diagnosis absolute. The object, therefore, when examining for renal calculi by this method of diagnosis, is to obtain negatives in which the shadows are shown of tissues less opaque than the least opaque calculus. Where such definition is obtained, it is certain that not even the smallest calculus can escape detection, no matter what its composition is."*

The fact remains, however, that up to the present time very skilful and experienced manipulators have obtained shadows supposed to be due to stones even of large size, when no stone has existed; and on the other hand have failed to obtain shadows of really existing stones.

Probably the uncertainty hitherto experienced in obtaining shadows of calculi *in situ* in the kidney is in part due to this fact, that an exposure sufficient to penetrate the [depth of the tissues is an over-exposure, at any rate for biliary and certain urinary calculi.

The light and exposure need to be adapted to each individual case, and to the depth of the tissues and the absorptive index of the particular calculus. The position of the patient and the effect on the kidney of the respiratory movements whilst the rays are at work are also of great importance. The condition of the patient and the composition of the stone in different cases no doubt require special treatment. Changes and improvements are made so suddenly in radiography that effects may soon be produced which will enable tuberculous deposits, abscesses, and possibly even renal and ureteral deformities, to be recognised; but if it demonstrates with certainty only the presence or absence of a calculus without being also able to reveal the other morbid conditions remediable by operation which mimic calculus, it will, I fear, be the means of putting back renal surgery by deterring many patients from submitting to surgical explorations who can be cured by no other treatment than an operation.

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* *See* paper by Charles Lester Leonard on "The Röntgen Ray Diagnosis of Renal Calculus," *Annals of Surgery*, Feb., 1900; *Philadelphia Medical Journal*, Aug., 1898, and April, 1899; and an address by C. Mansell Moullin on "Radiography, with special reference to the Detection of Renal Calculi," *Lancet*, March 27th, 1899.

Complications of renal calculus.—To the symptoms due to the sojourn of a calculus in the kidney or to its impaction in or transit down the ureter ought to be added those arising from the ordinary complications to which these calculi give rise. Either hydro-nephrosis, calculous anuria, perinephritis and perinephric abscess, peri-ureteritis and peri-ureteric abscess, pyelonephritis, pyo-nephrosis, and ulceration and subsequent stricture of the ureter may be developed. As each of these subjects is dealt with in other chapters the reader is referred to them for a description.

Hydro-nephrosis.—In 6,541 post-mortem examinations at the Middlesex Hospital, one or both kidneys were found in a state of hydro-nephrosis in 386. Of these cases of hydronephrosis the cause in five was calculus in the kidney or ureter. Roberts found impacted ureteral calculus the cause of hydronephrosis in eleven out of thirty-two cases, and Simon in seven out of eighteen cases of hydro-nephrosis.

Mr. Warrington * recorded a case under Mr. Collier at St. Mary's Hospital of hydro-nephrosis due to the blockage of the ureter or renal pelvis by uric acid calculi. The fluid in the distended kidney was highly albuminous, *loaded with cholesterine crystals,* and contained 9 per cent. of urea. The diagnosis had rested between a hydatid cyst of the liver and hydro-nephrosis.

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* *St. Mary's Hospital Gazette*, Jan., 1898.

CHAPTER XXV.

RENAL CALCULUS *(Continued).*

Diagnosis.—The difficulties in diagnosis of renal calculus arise from four chief causes: (1) Several other renal and ureteral affections give rise to the same symptoms as stone; (2) several diseased conditions of other organs cause symptoms which simulate those of renal calculus; (3) symptoms caused by renal calculus may be referred to other organs, and not to the kidney itself; (4) calculi may be masked for an indefinite time, giving rise to no symptoms whatever, yet causing the while progressive destruction of the kidney.

When calculi have been previously passed, when well-marked attacks of renal colic occur, when crystals of uric acid or calcium oxalate are frequently found in the urine, and when the urine is intermittently mixed with a good deal of blood, or persistently contains a microscopic quantity, there are the strongest *a priori* grounds for thinking that a stone is present. This evidence is strengthened if attacks of colic and hæmaturia are readily induced by exercise or jolting, and readily subside with rest; and if a sharp pain or distinct tenderness is always caused by bimanual examination of the renal region. In many cases, however, mistakes in diagnosis are bound to arise. Morbid conditions other than stone will be found, from time to time, in cases in which the character of the pain and the state of the urine point to calculus as the probable cause. The experience gained by operations by those who have had large practice in renal surgery has taught us much as to what the conditions are which cause symptoms typical of stone when no stone exists.

In 1892 * I published some lectures on the conditions simulating renal calculus as verified by surgical exploration in twenty-eight cases. To these I have since added † sixteen cases, making forty-four in all. In six instances a calculus was in the ureter at the time of the exploration, but in the greater number of the remaining thirty-eight cases some other morbid state of the kidney was found and remedied. Among the conditions were foci of tuberculous disease; a misplaced or freely shifting kidney; small abscesses or suppurating cysts; solid renal or perirenal tumour or cyst; blood extravasated beneath the fibrous capsule or pent up within the cavity of the kidney; a kidney hampered by tough adhesions (which in one of my cases were as dense and hard as cartilage) due to perinephritis provoked by sprain or other injury or disease; a ureteral stricture or an obstructing valve. In other cases I have found the kidney more or less displaced and greatly engorged with serous blood owing to distortion of the veins at the hilum or their compression by condensed fibro-lipomatous tissue. Newman has reported a case of this latter kind. Another important class of cases in which the symptoms simulate renal calculus is ureteritis.

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* *Brit. Med. Journ.*, April and May, pp. 896–1007.

† "Hunterian Lectures," 1898.

The above are some of the conditions which have been met with in the search for stone in the kidney, and which in many instances have been most successfully cured.

But there are many conditions outside the kidney, as well as those connected with that organ, which give rise to symptoms suggestive of renal calculus. I have known instances of each of the following diseases being the subject of mistake: (*a*) gastric ulcer; (*b*) malignant and tuberculous growths in the intestines; (*c*) intestinal adhesions, whether involving the renal pedicle or not; (*d*) aortic or cæliac aneurysm stretching the ureter or renal vessels; (*e*) spinal disease, causing perinephric suppuration; (*f*) vesical calculus; (*g*) abscess, and calculus in the prostate; (*h*) growths in the bladder; (*i*) ovaritis; (*j*) tuberculous disease of the Fallopian tube; (*k*) a gallstone in the cystic duct.

Lastly, there are certainly cases in which neither within nor without the urinary organs has anything been discovered to explain continuous discomfort or attacks of paroxysmal pain in the renal region; and yet complete relief has followed an exploratory operation. These are the cases which for the want of better knowledge have been called nephralgia.

In order to arrive at a correct diagnosis as to the presence of a stone, close attention should be given to each individual symptom.

Pain.—The chief characteristics of the pain of renal calculus are its occurrence in the form of sudden attacks of colic; its liability to be induced by movement and shaking, and to be calmed by rest in the horizontal position; its usual situation immediately below the last rib and just external to the erector spinæ muscles behind, and at or just below and a little nearer the median line than the point of the eleventh rib in front; and lastly, its tendency to radiate along the course of the ureter to the groin, and to the testicle in the one sex and the labium majus in the other.

Jordan Lloyd believes in the stabbing pain in the kidney experienced on percussion or succussion. Franks asserts that the only symptoms which have been present in all cases are pain radiating from the region of the kidney and tenderness over the affected organ. Hurry Fenwick* believes renal pain to be the most important of the symptoms, and finds in a certain number of non-suppurative cases in which a stone is fixed or embedded that the patient is forced to sleep on the side of the stone, and cannot turn over to the opposite side without increasing the pain. This in many cases is quite correct.

It must always be borne in mind, however, when investigating the character and situation of this symptom, that pain not very unlike that excited by a calculus may be caused by other and very dissimilar renal affections: by intercostal and lumbar neuralgia; by biliary calculus; by disease of the spinal column of either a tuberculous or malignant nature; and by malarial nephralgia.

On the other hand it must not be forgotten that a calculus may be present in the kidney without ever having given rise to any pain whatever; or pain more or less acute may have been felt for a time, and may then have disappeared for a long period or altogether.

Hæmaturia.—The most striking characteristics of the hæmaturia due to renal calculus are the following: (1) It is frequently if not usually induced by movement or shaking; (2) it is associated generally with an attack of colic or, if not, with a sense of great discomfort or increasing pain in the kidney region; (3) the hæmaturia, like the pain, ceases under the influence of rest in the recumbent position, the pain generally passing off many hours before the urine is quite clear of blood; (4) the amount of blood passed is seldom profuse or obstinate, though in rare cases it has proved to be both; (5) the colour of the urine is generally pink or bright red, but may be dark, or the urine may have the appearance of porter or coffee and give a blackish sediment after standing; (6) the blood is evenly diffused through the urine; (7) clots of blood taking the shape of the calyces or ureter are exceptional in renal calculus.

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* "The Pain of Renal Stone," *Trans. Med. Soc.*, vol. xix., p. 282.

Hæmaturia is looked upon as almost a necessary result of calculus; and probably it would not be far wrong to say that renal calculus causes hæmorrhage from the kidney, combined with pain in the renal region in a majority of cases.

But, besides resulting from various other renal affections —such as tumours innocent and malignant, including nævoid or angeiomatous patches of the parenchyma or the papillæ; tuberculosis; and injuries including slight concussions as well as severe lacerations of the kidney—renal hæmorrhage sometimes occurs when there is no ascertainable cause for it, from a mere relaxation of the blood-vessels or from simple increase of intra-renal blood pressure. If such hæmaturia occurs in a rheumatic or highly nervous or hysterical person, the symptoms of renal calculus may be very perfectly simulated.

On the other hand, a stone in the kidney may not cause hæmaturia at all, or not during the time the patient is under observation. If the quantity of blood passed has been slight, its presence may never have been observed by the patient; and if the hæmaturia is intermittent, the most careful examinations, extending over many weeks or months, may not discover it. A stone may have existed a long while in the kidney without having ever given rise to hæmaturia until some slight blow, or a strain, followed or not by a sharp pain in the renal region, provokes hæmorrhage. In such a case the character and the slightness of the injury should make the surgeon suspect the possible presence of a renal calculus.

The clinical history as to hæmaturia is, however, all-important, and will sometimes help to save us from great errors. Owen Rees recorded how a young lady of marked hysterical disposition had lumbar pain and frequency of micturition set down to hysteria, and was treated accordingly; until, at length, due attention to the clinical history revealed that hæmaturia had existed on more than one occasion. A mulberry calculus was ultimately found in her kidney.

The "essential hæmaturia," or hæmaturia with macroscopically unaltered kidneys, is very rare, and there is in most of such cases an absence of colic, and of the changes in the urine met with in calculus.

Tumour.—As a rule there is no tumour in ordinary and uncomplicated cases of renal calculus. There is, however, sometimes temporary or permanent enlargement of the kidney (1) from vascular engorgement; (2) from nephrectasis, whether non-suppurative in the form of hydro-nephrosis or hæmato-nephrosis, suppurative in the form of pyo-nephrosis; or (3) from fibro-fatty hypertrophy of the perinephric tissue produced by the irritation or renal obstruction. Sometimes, however, a calculous kidney forms a large, hard, immovable solid tumour of great size which is very liable indeed to be mistaken for a malignant new growth. I have operated upon two such cases, and they were two of the most formidable renal operations it has been my lot to perform. I have recorded one of these cases;* the other was performed in July, 1899, upon a male patient fifty-four years of age with calculous pyo-nephrosis due to a very large stone; he had been treated for a long time as a case of very slowly progressive malignant tumour.

Frequency of micturition is also a symptom which requires great attention. It is the offspring of many causes, renal, ureteral, vesical, prostatic, and urethral, but it is a very common symptom of renal calculus. In some cases the irritation at the neck of the bladder is so excessive that the thought of a calculus in the kidney or ureter does not arise, but catheters and sounds are again and again resorted to on the supposition that the seat of disease is the urethra or bladder. If the frequency of micturition be associated with pus in the urine, cystitis is pretty surely said to exist, whilst in reality the pus is coming from the higher urinary passages; and the cystitis, if it existed, was probably the direct result of the so-called "exhaustive examinations" with instruments or over active treatment of the bladder.

I have known a case in which, for many months, the patient was looked upon by eminent men as suffering from subacute cystitis; but the pus in his urine came from a calculous kidney, and in the end he died from a large abscess extending into the perinephric tissue.

I have above referred to the case of a lady who for nine years had a vesico-vaginal fistula established on account of vesical irritation of inordinate severity. All the bladder symptoms subsided and the fistula was permanently closed after removal of a small lozenge-shaped calculus from her kidney. This is the most striking and severe case I have ever known of transferred pain from renal calculus.*

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* "Hunterian Lectures," pp. 71, 72 (1898).

Dickinson relates that "a young woman died under his care in St. George's Hospital with symptoms of pyelitis, which might have been the result of either stone or tubercle; but her distress was almost wholly vesical; the urine, which was persistently purulent, was passed with much frequency, pain, and difficulty, and the catheter was often needed. Both kidneys were occupied by large rough stones, the bladder and urethra were perfectly natural, the vesical trouble wholly of renal origin, no doubt in part due to the irritation of the purulent and alkaline urine."

Whilst a calculus is hollowing out a nest for itself in the kidney, or is growing in a calyx or in the renal pelvis, a slight degree of pyelitis goes on and causes purulent urine, and often irritability of the bladder. When this encysting process is completed and the calculus is quiescently lodged, the pus disappears from the urine and the frequency of micturition subsides. The length of time this process lasts is very uncertain, and varies from a few weeks to a year or two, or more. If it be not too prolonged, and the sufferer be healthy, perfect convalescence may follow; but if the process be very prolonged, or the patient be tuberculous, aged, or weakly, renal abscess, pyelo-nephritis, or perinephric abscess and death result. A correct diagnosis may generally be made in cases of frequency of micturition if, besides small quantities of pus, there be also from time to time a little blood in the urine, and more or less constant paroxysmal pain in the lumbar region and in the groin or testicle. When the lumbar or testicular pain is absent, frequency of micturition, with purulent and blood-mixed urine, is insufficient for a correct diagnosis; and, even though renal calculus be the cause, there are no data for selecting one kidney rather than another for lumbar exploration, unless indeed information is afforded by the inspection of the ureteral orifices and the separate examination of the urine from each of the kidneys.

We will now briefly review the differential symptoms of the several affections with which renal calculus has been most frequently confused.

Intercostal and muscular neuralgia and lumbago.—Pain of this nature affecting the lowest intercostal or the abdominal or spinal muscles is of a duller, less acute character, is generally in abeyance during complete rest of the muscles affected, and is aggravated every time the particular muscles are put into action. The pain is accompanied by a marked sense of fixation or "setting" of the muscles affected, which become relaxed with action although the actual pain does not pass off and may not even be diminished. There is stiffness and tenderness generally on both sides of the middle line, especially marked when the patient stoops or rises, coughs or sneezes. Warmth, counter-irritation, and rest often quickly cure the patient, who may remain subsequently quite free from any return. Most frequently there is an entire absence of hæmaturia, of crystals or gravel, and of every form of urinary disturbance. Even in rheumatic, dyspeptic, or lithæmic subjects, who are very prone to muscular neuralgia and to pass urine highly charged with uric acid or the urinary salts, there is not usually hæmaturia or frequent or painful micturition. The rapid improvement under alkaline treatment and diluents will contra-indicate the presence of a calculus abiding in the kidney or ureter. Jolting movements do not excite renal colic and hæmaturia as they so frequently do when a calculus exists.

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* "Hunterian Lectures," p. 64 (1898).

Spinal caries.—Pott's disease and malignant disease of the spinal column have in rare cases been mistaken for renal calculus (Wright, *Med. Chron.*, No. 6, p. 642). The fixity and rigidity of the spine, the general appearance of the patient, the progressive course of the disease, the local tenderness on percussion over the spines of the vertebræ, and the onset of the deformity which so generally marks the progress of tuberculous or traumatic disease of the vertebral column, will form the basis for the diagnosis. If urinary symptoms are present they will indicate loss of power rather than irritability of the bladder, and the urine will give evidence of septic changes. Hæmaturia and renal pain will most probably be absent, though both may be caused by pressure effects on the kidney of a spinal abscess. Secondary renal calculus may be formed in long-standing cases of spinal affections. Cases of spinal abscess simulating renal calculus have been observed by Erichsen, Wright, T. Myles, and myself.

In two cases of malignant disease of the spine in which I have been consulted, symptoms of renal calculus were marked, and in one of them a stone was present in the kidney. In the other, intense pain in the left kidney region only, aggravated by movement and associated with hæmaturia, were present. The hæmaturia came from a sarcoma of the right kidney, the pain was caused by a growth involving the left side of the tenth and eleventh dorsal vertebræ.

Nephralgia.—Nephralgia due to malarial poisoning, presenting symptoms very like those due to the passage of a renal calculus, has been witnessed by F. W. Kirkham in the Isthmus of Panama, and by Tiffany of Maryland.

The paroxysmal and radiating character of the pain in malarial nephralgia, and the abundant hæmaturia which often accompanies it create a group of symptoms which closely simulate renal colic. The points for diagnosis are the elevation of temperature, residence in a malarial district, the presence of the plasmodium malariæ, and the immediate relief afforded by a course of quinine. Tiffany speaks of having seen a number of cases of malarial hæmaturia in which there was no remittent or intermittent fever.

Nephralgia is said to occur under other conditions,* as in hysteria; in renal congestion from nervous excitement; in the paroxysmal renal pain sometimes met with in abdominal aneurysm. Errors in diagnosis may arise also in connection with hypertrophy of the left ventricle the result of aortic regurgitation, and other forms of organic disease of the heart in which neuralgic pain is referred to as being deeply situated behind the first part of the duodenum, passing downwards into the right lumbar region; or connected with gastric or intestinal symptoms but in which the urine is quite normal; in pleuro-pneumonia, when the pain, as is often the case, is at first more lumbar than dorsal; in association with an abscess in the cellular tissue between the rectum and bladder, or with duodenal ulcer; or with a lumbrical worm in the intestine; or with the engorgement and enlargement of the kidney which occurs in some delicate women during the menstrual period; and in the aching pain in the kidney, attended with marked hæmaturia, which is in rare cases symptomatic of granular kidney.†

Mr. Howard Marsh ‡ has recorded a case in which the right kidney was twice explored with negative result for calculus on account of paroxysmal attacks of pain, scanty urine and hæmaturia, which he considered were due to a neurosis in the form of a profound disturbance of the vaso-motor system of the kidney of the same nature as Raynand's disease. The left kidney, which was small, movable, and contained calculi, had previously been excised.

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* Address by the author before the Medical Society of London, 1885 (*Brit. Med. Journ.*, vol. i., p. 311).

† *See* address by the late Dr. Ralfe in the section of medicine at the Annual Meeting of the British Medical Association in Dublin, August, 1887 (*Brit. Med. Journ.*, January 28th, 1888).

‡ *Trans. Clin. Soc.*, 1892, vol. xxv., p. 195.

Vascular tension.—Various local causes of increased vascular tension in the kidney cause renal pain, hæmaturia, albuminuria, and hyaline casts—symptoms simulating renal calculus. Such symptoms may be caused by torsion of the renal vessels or the ureter; by strain, not unfrequently brought about by movable kidney; or by a firm cicatricial band, due to injury, encircling the kidney or compressing its pedicle.

Aneurysm of the descending aorta pressing on the side of the spinal column may give rise to pain very similar to that of renal colic. In one case, a captain in the navy who had been many years in China came home for treatment for supposed renal calculus. His urine was normal, however, and on careful palpation of the abdomen I thought I detected abnormal pulsation to the left of the spine, and I diagnosed abdominal aneurysm. The diagnosis was not confirmed by one physician, but was by a second, and the patient died suddenly from rupture of the aneurysm within nine months of his arrival in this country.

Biliary colic may be confounded with the colic of renal calculus, and so, it is said, may be appendicular colic; but in the former occasional jaundice, in the latter fever, and in both the probable absence of urinary symptoms will assist the diagnosis.

There are a few cases in which a renal calculus has led to a perinephric abscess and given rise to a swelling and other symptoms which have been mistaken for those of appendicitis, and when the large abscess has been opened renal calculi have been found and removed from it.*

Gall-stones are not seldom found in the same individuals with renal calculi, as they are also with movable kidney. Murchison pointed this out, and others have observed the same. Once when fixing a movable kidney I detected through the peritoneum in the loin wound a gall-stone in the cystic duct, and removed it by the usual method after completing the nephrorrhaphy: the patient made a good recovery. Wright, of Manchester[*] recorded a case in which a stone diagnosed as being in the middle of the right ureter was removed and found to be a gall-stone; the patient died of acute peritonitis and after death a stone was found in the pelvis of the right kidney.

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* T. Myles of Dublin. See *Edin. Med. Journ.*, September, 1897.

From lithiasis and nephralgia due to functional derangement of the urine.—There is a great resemblance between the symptoms of renal calculus and those of hyper-acid urine. There is no more certain cause of pain in the loins, of frequent micturition, and even of a slight amount of pus or blood in the urine, than very acid urine, and urine overcharged with uric acid or calcium oxalate crystals.

The hyper-acidity of the secretion, or the crystals of uric acid, and oxalate of lime, by irritating or inflaming the mucous membrane of the kidneys, cause albuminuria, slight hæmaturia, or the admixture of pus with the urine, and also lumbar pains and frequency of micturition; and this may go on for months or a year or two without causing any actual or permanent degeneration of the renal tissues. The patients who are prone to these conditions are often of a gouty diathesis, are stout and plethoric, have a furred tongue, full pulse, much thirst, a tendency to drowsiness or headache, and their urine is often very thick and scanty. They suffer much, occasionally, from irritability of the bladder; frequently get a good deal of feverishness, and, though they do not experience acute pain in the testicle, will sometimes complain of marked testicular tenderness on pressure.

The diagnosis in such cases will be cleared up by the improvement which follows upon alkaline treatment or a course of piperazine. The citrate or tartrate of potash or soda, given every four hours during the day, neutralises the acidity of the urine as it is secreted, and thus the cause of the symptoms disappears, and with it the symptoms themselves. Moreover, these alkaline salts, by producing a supercarbonate of the alkali in the urine, dissolve the uric acid and the earthy phosphates, and thus not only tend to prevent the formation of urinary calculi, but, by diminishing their size, facilitate the expulsion of any small concretions, if such have already formed and are adherent or otherwise retained.

Where there is a persistent tendency to the formation of uric acid calculi the symptoms again and again recur, and yield again and again to the alkaline treatment. As the treatment promotes the descent and discharge of the gravel and of small calculi, the patients are apt to condemn the remedy as being the cause of their trouble, instead of honouring it as the means of their deliverance.

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[*] *Lancet*, 1885, vol. i., p. 563.

Another class of patients who suffer from renal nephralgia and lithiasis are thin, spare, neurasthenic and dyspeptic persons; they complain of aching or soreness in each loin and over the sacrum, with a sensation of heat, or of pain shooting towards the groins, and various nervous disturbances, and there is an excess of phosphates in and a deposition of calcium oxalates from their urine. These cases are often obstinate in their course, lasting years, and may lead to a little hæmaturia or slight pyuria from chronic pyelitis.

Movable kidney may give rise to such severe paroxysmal pain as to simulate renal colic from calculus. The explanation of this has been already given. As a rule the urine is unchanged even during or after the attacks due to mobility, though it must not be forgotten that very occasionally the congestion which occurs from tension of the renal pedicle causes a certain amount of blood to appear in the urine.

The same kidney is sometimes movable as well as the seat of calculus; and the co-existence of these two conditions ought to be suspected in every case of movable kidney in which the urine contains blood or pus. The pain of movable kidney, like that of renal calculus, is often brought on by jolting, walking, or standing, and is relieved by rest, so that this symptom is in no way diagnostic.

Renal new growths.—The great distinction between renal neoplasms and renal calculus is that pain and hæmaturia due to new growths are independent of jolting and other movements. The hæmaturia is more abundant, besides being spontaneous, and it is as little controlled by rest as it is unlikely to be induced by exercise. Patients with renal new growths may or may not have a history of previous lithiasis—very probably, however, not. They not unfrequently pass blood-clots which are casts of the ureter, and which are sometimes many inches in length. On one occasion, as I have already said, I pulled out, hand over hand, a clot forty-two inches long, of which an inch or two was protruding at the external urinary meatus when I saw the patient.

Vesical tumours.—At the moment of writing I have a woman of thirty-five under treatment who for four years had been suffering from hæmaturia, pain referred to the right ureter and kidney and over the sacrum, as well as frequent and painful micturition. On admission her urine was alkaline and contained pus. She was sent to me by an able practitioner, who supposed her to be suffering from right renal calculus. The removal of a nearly sessile fibro-papilloma situated just in front of the right ureteral orifice and between it and the orifice of the urethra has given her full and complete relief.* In a paper published in the *Lancet* of October 31st, 1896 (p. 1210 *et seq.*), I drew attention to the importance of bimanual examination of the urinary bladder under anæsthesia in diagnosing renal from vesical tumours, and to this publication I would refer the reader for a description of three cases of vesical growths in the male bladder correctly diagnosed by this method of examination, each of which before coming under my care had been supposed to be suffering from renal disease. By this method I was permitted to examine and diagnose a tumour in the bladder of another male patient who had suffered from profound hæmaturia, on account of which one of his kidneys had unhappily been needlessly removed.

Vesical calculus.—In quite a number of cases I have re-removed calculi from the bladder of patients who have been sent to me for supposed renal trouble. In two or three instances the patients have had calculi in one or both kidneys as well as in the bladder, but in several only in the bladder, and all symptoms have been removed by litholapaxy.

Besides bimanual examination, the sound will clear up the question of vesical calculus, whilst the cystoscope and, in women, digital examination of the bladder will decide the diagnosis as to tumour. There is no difficulty in making the diagnosis if only the surgeon will remember that, just as in renal calculus all symptoms may point to the bladder or ovary, so in vesical growths and vesical calculi the pain may take the character of nephritic colic and the hæmaturia may in consequence be regarded as renal.

Various diseases of the prostate and vesicula seminalis.—Tubercle, abscess, and stone in these organs may give rise to symptoms which resemble those of renal calculus. If, when stone or tubercle of the kidney is suspected, a careful examination *per rectum* is instituted, and the prostate and vesicula are thus digitally examined, mistakes will generally be avoided. The urine should be voided at the same act of micturition into three separate utensils, and each quantity separately examined. In prostatic disease the first or the third portion passed will be more abnormal than the intermediate portion; in renal disease the blood or the pus will be uniformly distributed throughout the urine, which will be distinctly acid unless neutralised by an excessive quantity of blood or pus.

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* This patient subsequently returned with a recurrence of the vesical papilloma which I removed. Many months still later she developed a sarcoma in connection with the right os innominatum, and this possibly was the cause of the original right-sided renal, ureteral, and sacral pain, the urinary symptoms being due to the vesical papilloma.

Chronic and subacute nephritis.—In some cases of chronic nephritis there is localised renal pain, with more or less blood or albumen and renal casts in the urine. If the pain is more on one side than on the other, and if the hæmaturia, as in some cases it is, is persistent or considerable, renal calculus is likely to be suspected. Where there has been no loin pain, but marked hæmaturia, and aching in the bladder such as a quantity of blood in that viscus often excites, I have known nephritis mistaken for vesical calculus. The low specific gravity of urine and the presence in it of casts, the general malaise and loss of power, energy and will, point to the correct cause of the illness, especially if there is high arterial tension and cardiac hypertrophy. Nephritis, which follows exposure to cold or damp, or influenza or scarlatina, is not unlikely to give rise to symptoms like renal calculus.

Ureteritis simulates renal calculus very typically. One of the best described cases of the sort was published by Israel, who twice explored a small hydro-nephrotic kidney without discovering the cause, which really lay in an inflamed, thickened and constricted ureter. There was no stone: all symptoms ceased after nephro-ureterectomy. The way to the differential diagnosis of renal calculus and ureteritis is by a careful clinical investigation of the history, a careful bedside examination of the whole course of the ureter, and a more thorough and methodical examination of the kidney *and ureter* at the time of the surgical explorations than is generally even nowadays made.

Renal tuberculosis.—Probably *the greatest difficulty in diagnosis is between early tuberculous kidney and renal calculus.* The symptoms are at first almost identical, and the renal tuberculosis has often made great progress before its real nature is apparent.

When frequency of micturition and slightly purulent urine are met with in a person of tuberculous history and appearance, unaccompanied by a history of hæmaturia but with slight elevation of the temperature, the tuberculous nature of the disease is fairly clear; but when they are associated with a history of hæmaturia and sharp lumbar or testicular pain in an otherwise healthy-looking person, calculus is much more probable.

In all cases of doubt a very careful examination must be made of the other organs in which tubercle is likely to occur, but especially of the testicle, prostate and vesicula seminalis. Frequent search for the presence in the urine of the tubercle bacillus should be made, and the inoculation test on guinea-pigs should be tried.

In renal tuberculosis the pain is not generally of a colicky character, and if it is it will be followed by the passage of muco-pus or blood-clot, not of a calculus.

The hæmaturia is not usually profuse, but is in many instances repeated, or continued or prolonged. My experience does not coincide with that of the French authors who teach that the hæmaturia of renal tuberculosis is frequently as profuse and serious as in renal new growths. Neither the pain nor the hæmaturia is influenced by exercise or rest.

Renal tubercle like renal calculus may be very insidious, and may continue for many years without exciting pyo-nephrosis or great enlargement of the kidney from circumscribed deposits or abscesses. It may also exist for years without passing beyond the limits of the kidney proper; or at any rate beyond the kidney and the upper end of the ureter and the surrounding cellular tissue.

In some cases, even during an exploration of the kidney, a nodule of tubercle, or a small abscess, at first not far from the surface, may give an impression of calculus from its hardness and outline and general tactile impression. But the exposed general surface of a tuberculous kidney differs much from that of a calculous organ. With tubercle the kidney has a yellowish-white, more or less mottled and starred or uneven surface; with calculus the renal surface is often uniformly smooth and of a dark red and congested look. This distinction refers to kidneys which are of normal or nearly normal size, and not to organs enlarged and misshapen by pyo-nephrotic changes.

It must be remembered that a calculus may be present in a tuberculous kidney; but this complication is an additional reason for removing the calculus. In certain cases of early tuberculous disease it might fairly be expected that the removal or escape of the calculus would lead to the cessation and repair of the morbid changes; whereas, on the other hand, if the calculus be not removed the destruction of the kidney will progress all the more rapidly from being associated with tuberculosis.

When with symptoms pointing to tuberculous disease of the kidney pain and hæmaturia are caused by exercise and calmed by rest, a renal calculus, as well as tuberculosis, should be suspected.

Diagnosis as to which kidney contains the stone.—This is not often difficult. If pain is a symptom the question of exploration has to be considered. It should be an invariable rule to explore the kidney on the painful side. If pain occasionally occurs on both sides, but is more frequent, severe, and persistent on one side, and never occurs on the opposite side without being present on both, the kidney of the side where there is most frequent and most severe pain is the kidney which should be explored.

In some rare cases of calculus, however, there is no pain at all; in others there is pain in both loins or even all over the body. When hæmaturia or pyuria is the only urinary symptom, there being nothing whatever to point to the side of the affection, the cystoscope and the ureteral catheter are of use. I have published ("Hunterian Lectures," p. 66) the case of a gentleman in whom pyuria, vague pains not referred to either kidney, a high temperature, a typhoid state, and great physical disturbance, lasting between two and three months, were followed by recovery after the discharge of a few ounces of pus and a few renal calculi.

A sign of no little significance, one which should always be sought for, and which I have often found of much diagnostic value, is the induration of the parietal muscles on one side of the abdomen and not on the other. The degree of resistance to palpation offered by the muscles on the side of the affected organ is often very considerable; it has on more than one occasion aided me in deciding which kidney to explore. Legueu has drawn attention to the value of this sign in a case of calculous anuria.

Diagnosis as to the situation of a calculus.—The possibility of diagnosing between a calculus situated in the renal parenchyma and in the renal pelvis has been described, but the diagnostic symptoms are not reliable, nor is the advantage of the distinction apparent. It is true that the Röntgen rays and the screen have enabled expert photographers to indicate to a nicety the position of a calculus within the kidney; but, as in every case of operation for renal calculus, the kidney and upper end of the ureter ought to be thoroughly tested by palpation and the ureter in its whole course by catheterisation, and as in the vast majority of cases this can be done whilst the kidney is on the surface of the loin and under the eye as well as within the fingers of the surgeon, it is quite immaterial whether he knows or does not know before operating if the stone is in an upper or a lower calyx or in the substance or pelvis of the kidney. It is, however, important to ascertain whether a stone is in the kidney or in the ureter. But to this end the situation to which pain is referred is of no value, because in some cases of renal calculus the pain is most intense, or entirely referred to a point in the ureter; whereas in some cases of ureteral calculus the intensity of the pain, or the only pain, is located in the kidney. The only evidence upon which reliance can be placed is actually feeling the stone, either through the abdominal walls or by rectal or vaginal examination, and testing the ureter by passing a bougie. As, however, the great majority of calculi when impacted in the ureter become fixed within a few inches of the kidney, they can be detected when exploring the kidney. By extending the ordinary incision for exploring the kidney, the ureter can be readily exposed down to the brim of the pelvis, and a calculus impacted therein can be readily removed as soon as its point of fixation has been detected by the ureteral bougie passed downwards from the renal pelvis.

Diagnosis as to the state of the second kidney.—The possibility of there being only one kidney has always to be remembered.

When both kidneys are present, and it becomes a question of removing one, the state of the other organ, as well as its existence at all, is of paramount importance.

In a great number of cases this can be easily told. (1) The second kidney can in some patients be distinctly ascertained by palpation to be normal in form and volume, whilst the characters of the urine assure us of its healthy secretion; (2) in many instances the affected kidney has been temporarily obstructed on one or more occasions, and meanwhile healthy secretion has been discharged by the opposite organ; (3) in certain cases the whole of the urine from one kidney is discharged through a fistula, the ureter of the corresponding side proved to be completely closed by the failure of coloured fluid injected at the fistula to reach the bladder, and yet healthy urine in good quality is passed off through the bladder. In such cases no artificial aid is required to inform the surgeon of the presence of a sound kidney on one side.

The diagnostic value of lumbar exploration.—When, however, there are no clinical signs by which to arrive at a conclusion as to the condition of the opposite kidney, we must have recourse to the cystoscope and ureteral catheter, or to exploration of the kidney, or if needs be of both kidneys, through an incision in the ilio-lumbar space behind.

Such an exploratory incision is required in all cases in which there occur attacks of colic or severe continued pain or severe hæmorrhage; and the surgeon should be prepared to proceed at once to any definite operation which the condition of the kidney after exposure indicates. In calculous anuria the presence of marked renal tenderness, or contraction and induration of the abdominal parietes on one side only, may be sufficient to determine the side to explore first.

The expectant treatment in cases of suspected renal calculus—unless the patient has on previous occasions passed calculi, and therefore presumably has a dilated or dilatable ureter—is not unattended with danger; and even when calculi have been previously passed it cannot safely be recommended owing to the alarming consequences sometimes lighted up by migratory calculi. It is better, and far safer, for the patient to undergo an exploratory incision for diagnostic purposes in the earlier stages of the affection than to run the risks of a far more dangerous operation when a stone becomes impacted in the ureter or has caused anuria, or after suppuration or extravasation of urine has occurred in the perinephric or peri-ureteral cellular tissue.

It is, however, as a rule, unsafe to search for a stone in the kidney when the perinephric tissues are in an acutely suppurating condition, and the lumbar incision has been made expressly to give exit to the pus of acute suppuration. It is better to defer the exploration of the kidney till the abscess has discharged and the tissues have quieted down.

Even when the kidney is exposed to the eye, and has been palpated all over with the greatest care and discrimination, and exploratory punctures have been made systematically in every direction into its substance, a calculus may yet easily escape detection.

I first published a case showing this fact, and in which I subsequently performed nephrectomy, in 1884.* It was the lesson taught by this case which led me to advocate and practise incision of the renal parenchyma in every exploratory operation. I have on several occasions since by means of an incision into the convex body of the kidney exposed and removed a small calculus which had evaded every other means of discovery. Kendal Franks, on April 5th, 1887, was one of the first surgeons, if not the first, to follow my suggestion to make the exploration complete by incising the kidney substance. In a case* in which there was absolutely nothing abnormal to be felt in the renal pelvis, and no hardness or inequality in the parenchyma to guide him as to the presence or position of a calculus, he made an incision about an inch and a half long in the convex border of the kidney, and thus detected and opened a small abscess cavity in which was contained a calculus the size of a pea. The patient made a good recovery.

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* *Roy. Med.-Chir. Soc. Trans.*, vol. lxviii.

Kendal Franks' paper, I have no doubt, gave an additional stimulus to the practice I had advocated, and he therein made the following remarks, which have an historical value:—

"This case is interesting in many ways, and I think it is one also of considerable importance. When Mr. Henry Morris excised an otherwise healthy kidney, and found in it a small calculus hidden away in one of the calyces—which on a previous occasion he had been unable to detect, either by digital exploration or by needle puncture through a lumbar incision—he suggested that it would be better practice to open up the kidney and explore the calyces, rather than to sacrifice a healthy organ. This advice has been unfavourably criticised in some quarters, but I venture to say that this case goes to prove the wisdom of the suggestion. Had I not cut into the kidney, I must have resorted to the more dangerous expedient of nephrectomy, or have been satisfied to leave my patient *in statu quo;* and I believe that the exploratory incision is by far the safest alternative."

The needle puncture as an exploratory measure has properly become discredited, and is not or ought not to be any longer employed; whereas an incision into the renal parenchyma along the convex border of the organ is now a recognised and ordinary procedure in every exploratory operation.

It sometimes happens that though one stone is found and extracted, a second and larger one escapes detection if the kidney is not thoroughly explored throughout. It is certainly unsafe to conclude because one calculus is found that there is not another to be discovered. Thus, after one of my early nephrotomies for calculus, symptoms persisted which led me a few weeks later to explore the same kidney a second time, when I removed a calculus weighing 360 grains, which I had overlooked at the first operation. This arose from my being satisfied with the removal of a calculus weighing 26 grains, and neglecting to thoroughly explore the rest of the kidney (Fig. 121).

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* *Brit. Med. Journ.*, March 31st, 1888.

It also sometimes occurs that the most careful examination of the kidney shows the absence of a calculus in it, yet a stone is present in the ureter; or a stone is found in the kidney, and a second is in the ureter. This has been my experience on five or six occasions. The ureteral calculus will be overlooked unless the ureter is explored by a catheter or bougie. I had instances in my earlier practice in which a calculus was passed within a few months after a negative exploration of the kidney. I have no doubt that in each of these cases the calculus was either shaken out of the renal pelvis by the manipulation of the kidney requisite for the purpose of exploring it, or was impacted in the ureter prior to the operation, and that I failed to detect it because I did not explore the whole length of the ureter. I have had an experience in one case which I think strikingly proves that a calculus is at times shaken out of the kidney into the ureter or bladder by the manipulations of the kidney during an operation. A young man was under my care with a calculus in the bladder and a calculous pyo-nephrotic right kidney. At the same *séance* I first performed litholapaxy

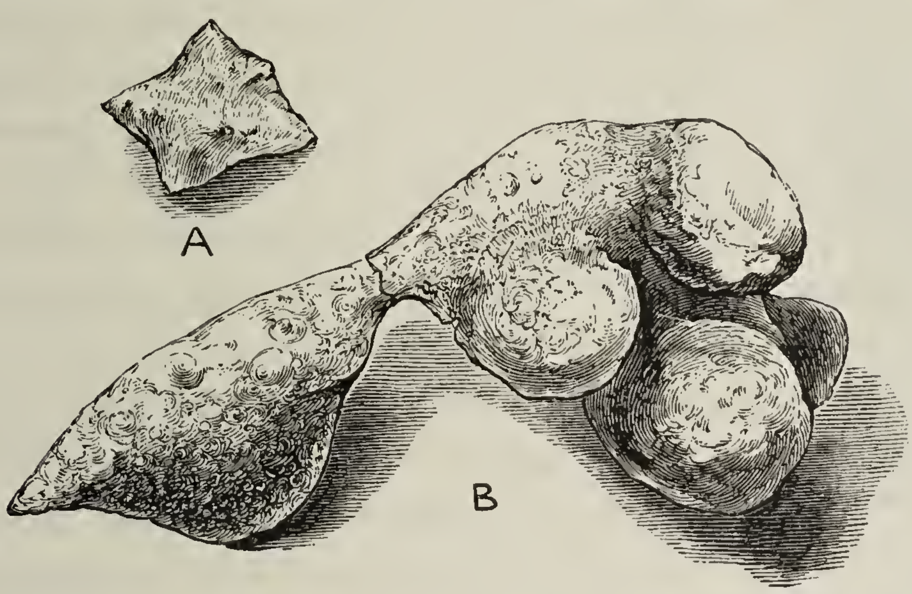

Fig. 121.—A, Calculus weighing 26 grains removed from Kidney at first operation; B, Calculus weighing 360 grains removed at second operation. (*Lancet*, vol. i., p. 88; "Hunt. Lect.," Table II., Nos. 3 and 4.)

and then removed the kidney. A day or two afterwards he passed a small calculus from his bladder, and on sounding the bladder I detected a second calculus which I removed by litholapaxy. In a comparatively early case, on catheterising the ureter after incising and thoroughly exploring the kidney, an obstruction was detected at the pelvic brim, and a small ovoid stone was passed by the patient some five months after. As the kidney was movable and the patient very neurotic I was led wrongly to infer that the obstacle was a slight kink of the ureter, and so I neglected to expose and palpate the ureter as I ought to have done. When the ureter is properly tested from end to end, and the seat of obstruction is exposed and examined, such disappointments to surgeon and patient will be almost certainly avoided.

In my operations for calculus I have found stones of all sizes, from two grains to ten ounces, and have removed them by nephrolithotomy or nephrotomy. I do not think a stone, however small, ought to be missed because of its diminutive size with the present method of exploring the kidney and ureter.

It does not detract from the value of exploratory operations as a means of diagnosis to have to admit that they have been often undertaken and no stone has been found. If this is a reproach to our capacity for diagnosis, it is far from being a disadvantage to the patients. The risk of an exploratory operation has been in my practice much less than 1 per cent. (131 operations,* 130 recoveries, and one death); whilst, as I have stated above, the exploration, if it has not led to the removal of a stone, has more frequently than not disclosed some other condition which has been rectified at the time of the exploratory incision.

Prognosis.—Any case in which a calculus is retained in the kidney ought to be regarded seriously, though far less seriously than one in which a calculus is impacted in the ureter.

It is the possibility of a migrating calculus becoming impacted in the ureter which makes the risk of the expectant treatment so great. The very alarming consequences of such a mishap are described in the chapter on Calculus in the Ureter, Part II., Vol. II., p. 446, to which the reader is referred.

Many small uric acid calculi may be passed with impunity by the same person; or, if the first has caused trouble, the subsequent ones may escape with ease, perhaps even without the knowledge of the patient until the stone is heard rattling in the chamber vessel.

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* "Hunterian Lectures," lecture iii., p. 81.

But we can never feel assured that a calculus which has entered the ureter will escape into the bladder. An angular-shaped smooth calculus of a size not exceeding a horse-bean, or a rough-surfaced oxalate of lime stone of minute size, not larger even than a grape seed, may become blocked permanently; and if not removed may either destroy the kidney by atrophy or distension with or without suppuration, or lead to a peri-ureteral abscess, or to a urinary fistula.

When a calculus is removed or escapes, the kidney which has been obstructed by it for many weeks may subsequently recover perfectly its full function, if the ureter is not permanently damaged; but the ureter at the situation of the impaction is apt to become stenosed or obliterated as the consequence of the injury wrought by the impaction. A calculus in the renal pelvis is sure to lead before long to atrophy, or nephrectasis, or to suppurative pyelo-nephritis. A calculus imbedded in a calyx or in the renal parenchyma is none the less a source of great danger because the risk it causes is not immediate. A stone so fixed may remain quiescent and unsuspected for years, and then at any moment light up mischief destructive of the entire kidney, and threatening to the life of the patient. An unsuspected or quiescent calculus may go on quietly growing till it reaches a great size; may cause intrarenal hæmorrhages which escape the attention of the patient; and ultimately and rapidly cause unbearable pressure symptoms, necessitating a very extensive and dangerous operation. I have previously mentioned cases of this sort, in which calculi of many ounces in weight, together with a large quantity of broken-down blood-clot, caused the enlarged and greatly distended kidneys to be mistaken for malignant new growths, whilst the sufferings they excited reduced the patients to the last stage of endurance. When operated upon a rapidly fatal result ensued in each case; in one by loss of blood from the renal tissues, in the other by shock attendant upon the removal of so large and so intimately adherent an organ.

In addition to the immediate effects of obstruction and suppuration in the kidney itself, there are also the more remote consequences. Suppuration after spreading to the perinephric tissue often terminates in tortuous and most intractable purulent and urinous fistulæ. There is, too, always the chance of the other kidney becoming subsequently affected by a calculus, and of anuria following as a direct consequence thereof (*see* cases by C. Lucas and Willy Meyer, referred to again in the next chapter). The prognosis of calculous anuria is in every case most alarming; the rate of mortality from this complication increases with each day of its duration. The prospect of the spontaneous expulsion of the calculus from the organ last involved, though not absolutely hopeless, is still well nigh so; and though an operation gives the only reasonable chance of recovery, still the rate of mortality of operations for calculous anuria is very high.

It is pleasant to look from these grave and alarming though possibly long-delayed effects of renal calculi which have been allowed to take their own course, to the very low mortality of nephrolithotomy, which is the operation for renal calculus in its earlier stages. If the results of nephrolithotomy are compared with the rate of mortality of nephrotomy and nephrectomy —the operations performed for advanced calculous disorders—the advisability of operating at as early a period as possible is clearly shown. McCosh[*] in 1888 put together fifty-two collected cases of nephrolithotomy with six deaths, *i.e.* a mortality of 11·52 per cent. These figures compared favourably with the mortality of nephrotomy for calculous pyelitis of that date, which stood at 33 per cent.; and with that of lumbar nephrectomy, which, quoting Gross, he gave as 36·93 per cent.

Newman in 1888[†] collected forty-two cases of nephrolithotomy without a single death, whilst the proportion of deaths to recoveries in sixty nephrotomies for calculus with suppuration was twenty-six to thirty-four, or 43·3 per cent.; a death-rate which even exceeded the mortality of nephrectomies for suppurative disease with calculus, which was 36 per cent. in sixty-one operations, viz., thirty-nine recoveries and twenty-two deaths.

Legueu up to 1891 gives a mortality of 5 per cent. in uncomplicated cases of nephrolithotomy.[‡]

In a list of operations published between 1883 and 1893 in America and the United Kingdom, which I collected from various sources, 115 nephrolithotomies[§] and nephrotomies show 103 recoveries, and twelve deaths, *i.e.* 13·8 per cent. mortality; thirty-two nephrectomies show twenty-five recoveries and seven deaths, *i.e.* 21·8 per cent.

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[*] *New York Med. Journ.*, April 14th, 1888.

[†] "Surgical Diseases."

[‡] "Des Calculs du Rein et de l'Uretère," p. 129.

[§] No distinction is made in many of the reported cases between nephrolithotomy and nephrotomy.

My own results in operations for calculus up to March, 1898, are as follow:—

	CASES.	RECOVERIES.	DEATHS.	MORTALITY PERCENTAGE.
Nephrolithotomy . .	34	33	1	2·9
Nephrotomy	43	33	10	23·25
Nephrectomy	17	12	5	29·4

If my own list shows a somewhat higher mortality for nephrectomy than my collection of published cases from all British and American sources, it must be borne in mind that mine contains all the cases operated upon by me up to the date of my delivering the "Hunterian Lectures," whereas the collected cases are in several instances reported because of being successful.

In calculous cases nephrotomy and nephrectomy are required, chiefly for pyo-nephrosis the result of long-standing obstruction and suppuration; yet there is no reason why this condition should ever be reached, or why the mortality should ever exceed 3 per cent., if only physicians would recommend and surgeons would be prompt to practise early operations for stone in the kidney. Early operations would not only save life, but would also prevent one of the most troublesome and offensive of the sequelæ of operations upon the calculous kidney, namely, fistula. It is exceptional for a permanent or long-standing fistula to follow nephrolithotomy. It occurred in only 6 per cent. of my operations, and of these cases the stones were of great size and the renal pelvis much distended. The weight of the stones was respectively 1,303, 830, and 513 grains. On the other hand, after nephrotomy for advanced calculous conditions, troublesome fistulæ followed in 37·5 per cent. Though in many of these cases the fistula ultimately healed, still the fact that there was a long-standing fistula in such a large proportion of cases affords a further argument in favour of early operation for stone in the kidney.

But the fistulæ which occur independently of any operation —which are due, in other words, to long-retained renal calculi— should appeal even more strongly to surgeons as an argument against delaying operative treatment for stone.

The persistency of these fistulæ, the recurrence of deep suppuration if the external orifice of the fistula is allowed to close, together with the abiding troubles caused by the continued presence of the stone in the kidney or ureter, will sooner or later induce the patient to demand surgical assistance.

Then the patient has to undergo risks and the surgeon to face difficulties which only occur when the perinephric structures are matted and hardened by long-standing inflammation or suppuration, and have become so densely adherent to the kidney capsule that it is often no easy matter to find the kidney.

In a stout person with a deep loin it may be quite impossible to distinguish the kidney at all by touch; whilst the resisting nature of the tissues and the depth of the wound make it impossible, except through a very extensive incision, and perhaps only after the excision of the last rib, to bring the kidney within sight.

Another and very important fact is that these condensed, contracted tissues fill the hilum and surround the whole of the kidney with a fibro-lipomatous mass, which shortens and stiffens the pedicle, and compresses and destroys the elasticity of the renal vessels and of the ureter. The result of this is that the kidney gets tucked close up against the spinal column, and as firmly set in its surroundings as if it were imbedded in plaster of Paris. If nephrotomy is done under these conditions, the renal artery is with difficulty controlled when the renal parenchyma is incised and the kidney cavity explored, and thus bleeding is apt to be very free. If nephrectomy is performed, the risks and difficulties in dealing with the pedicle are enormously increased.

Treatment.—The treatment of renal calculus may be considered under three heads: (1) Prophylactic; (2) palliative; and (3) surgical.

(1) **Prophylaxis.**—The prophylactic treatment is directed not only to the prevention of the formation of a calculus, however small, but also to facilitating and stimulating the expulsion of gravel and small calculi, and of preventing their prolonged sojourn and growth within the kidney.

In all forms of primary lithiasis the preventive treatment should consist in attention to proper rules of hygiene and diet.

Exercise in the open air; the daily bath, either simple warm water or an alkaline and sulphur bath; moderation in the quantity of food; and proper selection of articles of diet are not only useful but essential.

The digestive and assimilative functions must be kept in good order; an excess of nitrogenous food, whether of a vegetable or an animal order, must especially be avoided; and a free quantity of diluents must be taken.

Animal diet is not harmful if taken in proper moderation, and with a due amount of fluids; nor is the substitution of a vegetable diet any security against calculus, as is proved by the prevalence of this disorder amongst those who take little or no meat.

There can be no necessity to insist on the importance of regular exercise and plenty of fresh air; but for those who are unable from any cause to take open-air exercise or gymnastics, and for the very corpulent, a substitute of some value can be found in massage, and friction of the whole body after the daily bath by means of a coarse towel, or the horsehair gloves, or loofahs.

In the uric acid diathesis the preventive treatment consists (1) in securing an abundant excretion of water in the urine; and (2) in diminishing the acidity of the urine, which is the cause of the precipitation of the urates and the uric acid. Malt liquors, all rich, heavy, and imperfectly fermented wines, such as burgundy, port, sherry, and champagne; smoked, salted, or highly savoured meats; and all salads or other articles containing vinegar and any form of acetic acid should be avoided.

The theory as to the origin of uric acid is that it is the ultimate product of the transformation of nuclein—a substance which differs from a proteid in containing 7 or 8 per cent. of phosphorus in a molecule. If this theory is correct, it must be desirable to avoid all articles of food rich in nuclein, such as sweetbread, liver, brains, and an excess of butcher's meat. Light wines and spirits, largely diluted with water or aërated water, are the best form in which to take stimulants. With the object of securing an abundance of water in the urine, the use of diluents is of the greatest importance. Plenty of pure water, a tumblerful of hot water taken on an empty stomach before rising in the morning, and another on going to bed; distilled water, or one of the many forms of table water, such as Schweppe's soda, Apollinaris, Rosbach, etc., do great good by flushing the upper urinary canals and clearing them of an excess of uric acid and retained salts. The feebly mineralised waters, such as those of Contréxéville, Vittel, Evian, and St. Hilaire, both increase the amount of water and diminish the acidity of the urine; as do also the more highly mineralised springs of Vichy, Pougues, and Carlsbad. For persons who have a constant or excessive tendency to form uric acid, the mineral waters containing alkaline bi-carbonates, such as Royat, Vichy, Ems, Pougues, and Fachingen, from the last of which I have found excellent results, are indicated.

Medicine.—The alkalies, especially the bi-carbonates of potash and soda, citrate of potash, carbonate and benzoate of lithia, and acetate of potash, should be given with the object of preventing the deposit though not diminishing the production of uric acid.

Piperazine has gained a considerable reputation in gout and the uric acid diathesis. It should be given in ten-grain doses, three times a day, dissolved in a large quantity of pure or effervescing mineral water, or by dissolving the granular effervescing powder in three-quarters of a tumbler of plain water. It acts by dissolving the organic basis of calculi, as well as the uric acid. With the latter it forms very soluble salts, which are held in solution by the urine. Sidonal, the quinate of piperazine, exercises the twofold power of substituting hippuric for uric acid, and dissolving the latter. It may be given in fifteen-grain doses.

Urotropine acts as a solvent of uric acid as well as an antiseptic for the urine. It causes no digestive disturbances when given in the ordinary doses. It increases diuresis, has a great power in dissolving uric acid, and is a more powerful antiseptic for the urinary canal than salol. It has also been beneficial in some cases of renal colic. Cystamine is an excellent substitute for urotropine, and should be taken twice or three times a day in five-grain doses of the powder dissolved in water.

Glycerine, in doses of from fifty to sixty *cubic centimetres*, taken with an equal quantity of water, twice or three times a day, has in some cases given good results.

Turpentine and laudanum in combination, when taken internally, in a case recorded by Dickinson, uniformly produced a discharge of uric acid gravel, which sometimes amounted to more than four ounces in two or three days.*

Xanthine and Cystine.—As to the treatment of these diatheses we know little or nothing: the rarity of the cases affords us such slight experience of and such scanty opportunity for studying them. Exercise, warm clothing, the avoidance of excess in eating and of indigestible articles of food, and the internal administration of the mineral acids and other medicines which stimulate the action of the liver, may be safely commended.

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* Dickinson, "Renal and Urinary Affections," vol. iii., p. 881.

Oxaluria, or the oxalic acid diathesis.—There is the same necessity of fresh air and ample exercise, and for keeping the urine diluted and free of excess of acidity as in the uric acid diatheses. Hard water, and vegetables rich in oxalic, malic, and tartaric acids, such as green fruits, haricots verts, asparagus, tomatoes, rhubarb, gooseberries, sorrel, and large quantities of grapes, should be avoided.

The free use of diluents, hot water, distilled or soft water, or the ordinary table waters, and several of the mineral waters mentioned in the last section, are indicated.

Contréxéville and other waters containing a large quantity of lime are however contra-indicated. A liberal diet, consisting of fish, meat and vegetables, together with claret or other light wine, or whisky or brandy diluted, should be ordered. In certain cases of marked nervous depression and feeble digestion, good port wine or pure bitter ale will be of distinct benefit.

Medicines.—Tonics, such as nitro-muriatic acid, combined with some bitter infusion or with strychnine; quinine and the preparations of iron are of the greatest use.

Phosphaturia, or the phosphatic diathesis.—An excess of the earthy salts, particularly of the phosphate of lime, in urine which is not ammoniacal occurs in nervous, hypochondriacal persons, mostly men, of active minds and anxious or excitable dispositions, about the middle period of life. Many have a tendency to gout in the form of arthritic pains, but not of a sthenic form.

The urine may be alkaline and cloudy, but is more frequently neutral, clear, and of a lemon or pale orange colour. It deposits a white precipitate on heating, which clears with acetic or nitric acid; and also yields a bulky precipitate when to the cold urine a little liquor potassæ is added.

This condition of urine is often connected with some other morbid state such as diabetes, tuberculous disease, and epilepsy, to which the treatment has to be directed. When it occurs, and it does so but rarely, independently of any other morbid state or of any error of diet, it must be met by generous diet, tonic treatment, and the measures appropriate for neurasthenia and dyspepsia, which accompany it. The medicines indicated are the mineral acids and strychnine, the bitter infusions, quinine and iron, and maltine.

The preventive treatment of secondary calculi—that is, of phosphatic calculi deposited from urine which is septic and undergoing ammoniacal changes—is the prevention or correction of the septic influences and inflammatory and suppurative local conditions which arise from a multitudinous number of causes in the kidney itself, the ureter, the bladder, or the lower urinary passage.

With this object in view the general and dietetic treatment is subordinate to the local condition, be it pyelitis, ureteritis, or cystitis, which is the cause of the decomposition of the urine and the consequent deposit of the earthy salts.

The mineral waters, often so useful in the other conditions of lithiasis, are inappropriate, or, at least, must be employed with the greatest care and strictest supervision, if at all.

The prophylactic treatment above described would seem to have other powers than that of preventing the formation of calculi. There are many cases which pass under notice in which one or more small uric acid or oxalate of lime calculi are passed by patients, often quite painlessly, during a course of the regimen recommended, so that the inference is justified that some small calculi by this treatment become smaller or their surfaces more suitable for transit down the ureter, and that thus their escape from the body is rendered not only possible but sometimes easy. These facts, however, ought not to encourage either the profession or the patient to place much reliance upon such expectant treatment to secure the expulsion of a calculus however small. The dangers attending the migration and impaction of calculi in the ureter should not be put out of sight (*see* "Hunterian Lectures," pp. 75–78, and especially the lecture on "Calculous Anuria"); nor do such cases justify us in sanctioning the postponement for any length of time of nephrolithotomy.

We cannot, of course, expect at once to overcome the reluctance of patients to an operation, however free from risk it may be, nor to induce them to submit to surgical treatment before any trial has been made, and proved ineffective, of medicinal and dietetic means; nor is it right or wise in all cases to recommend immediate exploration on the very earliest appearance of symptoms indicative of renal calculus, for there is in many instances the uncertainty whether the symptoms, severe though they be, have not been caused by over acidity of the urine and gravel which may readily be discharged, rather than by an actual calculous concretion. For these reasons it is often desirable and proper, and still oftener it is insisted on by the patient, that a course of expectant treatment should be tried. During its trial, whether for three or six months or longer, the patient should refrain from any vigorous exercise, any shaking movements, or any very active bodily pursuits, if the dangers of a sudden and forcible impaction of the calculus in the ureter are to be avoided.

(2) **Palliative.**—During an attack of renal colic the palliative treatment consists in the use of anodynes in large and repeated doses, sufficient to keep the pain in check. By allaying spasm, these drugs also facilitate the escape of the stone; and, for the same purpose, the hot bath, hot opium, or belladonna fomentations to the loin and abdomen, and chloroform and ether inhalations, are useful. Anodynes may be given in the form of morphia injections subcutaneously; or in the form of morphia, opium, or belladonna suppositories. Alkaline treatment—the citrates and tartrates of potash and soda given as a draught every four hours—neutralises the acidity of the urine. This acidity irritates the inflamed renal structure and the urinary mucous membranes, and thus tends to keep up or increase the spasmodic contraction of the muscular coat of the ureter. These salts moreover by producing, as Owen Rees long ago pointed out,* a supercarbonate of the alkali in the urine are just what is required in order to dissolve the uric acid or the earthy phosphates. Under the administration of these salts, though uric acid may continue to form small calculi, yet the calculi come down and are voided. Warm diluents and diuretic drinks are sometimes recommended, with a view of urging or pressing on the calculus by increasing the excretion of water and accumulating its weight behind the stone. The patient should be kept in a relaxed posture, with the shoulders and thighs raised, thereby to diminish as much as possible the pressure of the abdominal parietes and the abdominal contents upon the kidney. Lycetol in fifteen-grain doses combined with half the quantity of bicarbonate of soda, taken morning and evening in a glass of mineral water, has been recommended, but I have no personal experience of its effect.

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* *Lancet*, 1857, vol. i., p. 496.

(3) The **surgical treatment** of renal calculus must be considered under the heads nephrolithotomy, nephrotomy, and nephrectomy. The technique of renal and ureteral exploration by an incision in the loin will be fully considered elsewhere, and need not be here described.

It is very necessary, in order to gain a clear idea of the principles on which surgical treatment should be based, as well as a just view of the results of the two operations, that a sharp distinction should be drawn between nephrolithotomy and nephrotomy.

Nephrolithotomy aims at removing the stone, and leaving behind a useful and healthy kidney.

Nephrotomy consists in cutting into a disorganised kidney, whether the kidney is enlarged or not and whether the cause of the disorganisation is stone, tubercle, or some other disease or injury. Inasmuch as stone is one of the commonest causes of pyelitis, and calculous pyelitis one of the commonest causes of tumours formed by purulent and urinous collections in the renal cavity, nephrotomy has been more frequently than not followed by the discovery of a calculus. But in too many of these cases it has been the tumour in the flank which has led to the operation, the stone having been allowed to go on in its work of destruction until it culminated in a large purulent collection which it would have been unsafe, if not fatal, to leave unopened.

Nephrolithotomy, therefore, is the operation for stone in the kidney. Nephrotomy is the operation for calculous pyelitis, or calculous hydro-nephrosis, or pyo-nephrosis. Nephrolithotomy is performed either by cutting through the parenchyma or through the renal pelvis. The simple incision into the renal pelvis has been specially named pyelotomy. Similarly, the removal of a calculus through the renal pelvis might be called pyelolithotomy, whereas its removal through the glandular tissue might be called parenchymo-lithotomy. Such multiplication of names is, however, quite unnecessary, and I employ the term nephrolithotomy to include all cases of removal of a stone from the practically normal kidney, no matter whether the secreting tissue or the pelvis of the kidney is incised.

Nephrolithotomy is destined to save the kidney; nephrotomy is performed when the kidney is more or less destroyed, and often where there is little or no kidney to save. To nephrolithotomy we should look as a *means of preventing* the disastrous pathological changes which are sure to be produced by a calculus which is aggressive in its course. To nephrotomy we can only appeal to save suffering and life when there can no longer be any notion of saving the kidney intact.

Nephrolithotomy, when considered from the point of view of the kidney, should be placed under the head of prophylaxis. Nephrotomy is too often only an imperfect means of relief, not of cure.

There is thus a very wide practical difference between the results of the two operations, as well as between the conditions for which they are employed.

The history of nephrolithotomy need not be discussed here. I gave a sketch of it in my "Hunterian Lectures" (1898), as well as in a paper in the *Transactions* of the Clinical Society as long ago as 1881, wherein I published an account of the first nephrolithotomy ever performed. The reader may refer also for information on this subject to an able article on the "Development of Surgery of the Kidney," in the *Annals of Surgery* (January, 1900), from the pen of L. S. Pilcher.

Nephrolithotomy should be performed when symptoms of stone are distinct; when there are no signs of its passing out of the body after a fair trial of medicinal treatment and rest; or when, in order to diminish or remove pain or hæmaturia, or both, the patient is compelled to abandon some or all of the ordinary pursuits of life. When anuria supervenes upon symptoms of calculus in one or both kidneys, the kidney which has last become affected should be first explored.

The symptoms which are sufficiently characteristic of stone in the kidney to justify an exploration of the organ are: persistent or recurring hæmaturia; the presence of a little pus or of crystals in the urine together with fixed or more or less constant pain in one loin, groin, or testicle, the pain being either of a dull aching or sharp pricking kind, or paroxysmal and occasionally associated with the other symptoms characteristic of renal colic.

Few operations in surgery are so successful as nephrolithotomy. No great operation is followed by a smaller mortality. Nephrolithotomy gives absolute cure, saving the kidney from progressive destruction, and the patient from what at any moment may prove to be an imminent danger to life.

No disease gives rise to such a variety of morbid changes in the kidney as calculus; and none is more certainly fatal when allowed to progress without surgical interference.

Whilst slowly or silently destroying the kidney, renal calculus often physically disables its victim by its unrelenting irritation, and its unyielding resistance to every form of medical and dietetic treatment.

For these reasons the surgical treatment of stone in the kidney will grow in confidence and in favour with the profession and the public as nephrolithotomy anticipates and renders unnecessary nephrotomy and nephrectomy.

Nephrotomy, at present the most frequent operation resorted to for calculous affections, will be required but rarely if nephrolithotomy is earlier and oftener performed. Calculous pyonephrosis is the result of long-standing irritation and progressive destruction of the kidney, and there is no reason why it should ever occur if physicians would recommend, and surgeons would practise early operations for stone in the kidney. That this is a consummation much to be desired is seen by the figures previously given of the mortality of nephrolithotomy with that of nephrotomy and nephrectomy for calculous conditions.

Nephrotomy is the operation for renal calculus when the kidney is dilated and atrophied but not septic, *i.e.* in calculous hydro-nephrosis, unless the degree of hydro-nephrosis amounts to complete or all but complete destruction of the secreting structure, and even so nephrectomy should not be undertaken unless the opposite kidney is known to be in a satisfactory condition.

In septic conditions—pyo-nephrosis, pyelitis with or without dilatation of the renal pelvis, with or without great thickening and sclerosis of the renal substance; renal abscess; and perinephric abscess associated with renal calculus—in any of these conditions nephrotomy is the operation for choice.

Nephrotomy is distinctly less fatal than nephrectomy in these cases; and, moreover, it can be practised, indeed must be practised, in order to give a chance of life, on those persons whose second kidney is absent, or is the subject of calculous disease, or is otherwise defective.

The disadvantages of nephrotomy as compared with nephrectomy in cases of calculous nephrectasis, pyelitis, or abscess, are (1) that fresh calculi may form in the diseased and enlarged organ after recovery from the operation, and (2) that fistula much more frequently follows nephrotomy than nephrectomy, when performed for calculous disease. But the reply to these arguments is (1) that a second or even a third nephrotomy has been, and may be, successfully performed on the same kidney, and that this same kidney may be the safeguard against complete anuria; (2) that if the other kidney is sound, secondary nephrectomy can always be resorted to, if need be; (3) that fistula sometimes follows nephrectomy as well as nephrotomy. But though fistula, it is true, occasionally follows nephrectomy for stone, it does so much less often than it follows nephrotomy, and less frequently than it occurs after nephrectomy for tubercle. This is doubtless due to the frequency with which chronic tuberculous ureteritis keeps up a fistula after nephrectomy for tuberculous disease, and requires ureterectomy for its cure; whereas, it is only in very exceptional cases, such as those reported by Briddon and Remy, that ureterectomy is required after nephrectomy for calculous pyo-nephrosis. In calculous disease, fistula after nephrectomy is exceptional unless advanced perinephritis or perinephric suppuration or ureteritis has previously existed; and although ureteritis or perinephritis has usually preceded the operation, still a fistula followed in only one out of twelve of my nephrectomies for stone, *i.e.* in a little more than 8 per cent.; whereas after nephrotomy for calculous conditions, fistulæ either temporary or permanent occurred in 37·5 per cent. of the operations. In many of them, it is true, the fistulæ subsequently healed, or were closed by operation; still the fact that a temporary fistula followed in so large a proportion of cases, while it affords an argument in favour of earlier operations for stone in the kidney, does not tell in favour of sacrificing a function-discharging remnant of an organ which may subsequently prove to be the only renal excretory tissue left in the body. Nephrotomy is the proper operation for calculous pyo-nephrosis—at any rate as a primary operation—because of the frequency of double calculous disease (*i.e.* of contemporary or subsequent calculous affection of the second kidney), and because nephrectomy of one kidney when the opposite organ is occupied by a calculus is almost certainly fatal.

In tuberculous disease, on the other hand, primary nephrectomy or nephro-ureterotomy is the better practice. The difference is due to the fact that the activity of the renal disease and of the ureteritis and peri-ureteritis which are secondary to renal calculi, will in great probability subside after the removal of the cause; whereas the active agents of tuberculosis are left behind after nephrotomy, and even also after nephrectomy if the disease has spread downwards along the ureter.

Nephrectomy for calculus in the kidney or impacted in the ureter, uncomplicated by hydro-nephrosis, pyo-nephrosis, or abscess, was performed in the early days of renal surgery by Czerny, Kosinsky, and by myself in one case because of the impossibility of detecting the presence or whereabouts of a calculus by the methods at that time employed for searching for it.* With our present manner of exploring the kidney by incising its substance or pelvis, and by catheterising the ureter from end to end, a calculus can hardly be overlooked by a surgeon experienced in renal operations. Nephrectomy of the practically normal kidney is never likely to be repeated in such cases.

Nephrectomy in cases of aseptic, atrophied, calculous kidneys has been performed by Moty, Howard Marsh, and myself. In my own case, operated upon in 1890, the kidney removed weighed only just over two ounces and was in a state of chronic interstitial nephritis, and contained cysts filled with calculous material; a uric acid calculus blocked the ureter two inches above the bladder. The right kidney also was small and the subject of chronic nephritis. The patient died on the second day after the operation. Moty's case also died.

Tuffier and Angona have removed by primary nephrectomy calculous hydro-nephrotic kidneys.

In such cases as these either atrophy or hydro-nephrosis may demand nephrectomy, but the operation ought only to be performed when the kidney is completely or all but completely destroyed, and when the opposite kidney has been proved to be normal. Otherwise there is not so much justification for nephrectomy in these aseptic conditions as in the septic, because in the latter the removal of the risk of continuing septicity may be a colourable reason for submitting the patient to the danger of nephrectomy with the opposite organ in an imperfect but not a useless state. In my own case there was no reason to suspect the opposite kidney of being atrophied and the seat of nephritis; but this is a reason all the stronger for not nephrectomising except as a last resource, if at all. The difficulty of extracting a calculus from the ureter two inches above the bladder would not nowadays be a reason for excising the corresponding kidney, but the calculus would be extracted by the inguinal or sacral route.

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* *See* communication by author to the *Med. and Chir. Trans.*, vol. lxviii., and the report of the discussion thereon in the *Brit. Med. Journ.* and *Lancet* of November, 1884; also *Brit. Med. Journ.*, 1892, vol. i., p. 1065, and *Brit. Med. Journ.*, 1893, vol. i., p. 4.

In septic conditions, with total or nearly total destruction of the kidney, the other kidney being known to be acting well, primary nephrectomy is the operation indicated.

The other conditions in which it should be employed are for a kidney which has become almost destroyed after nephrotomy for calculus has been already once or more than once performed. It is also to be practised in cases of intractable or incurable fistula following nephrotomy for calculous disease, but only conditionally on the opposite organ being healthy.

The mortality of nephrectomy is distinctly higher than that of nephrotomy; broadly speaking, in the proportion of twenty to thirty, namely, 20 per cent. for lumbar nephrotomy, and 33 per cent. for primary lumbar nephrectomy. The mortality of primary nephrectomy is higher than that of secondary nephrectomy by about 10 per cent. These figures are approximately correct as averages, but they necessarily vary somewhat with different operators and with the difference in the selection of cases made by different surgeons for the respective operations. Some surgeons perform nephrotomy for their worst cases, whereas others resort to nephrectomy in their worst cases, provided they have previously ascertained the working capacity of the second kidney to be good.

Partial nephrectomy will be the most conservative and most satisfactory operation in certain cases, where a localised abscess or cyst of the parenchyma contains a calculus or calculous material, provided there is no obstruction in the ureter from an impacted calculus or stricture, or abnormality. In each of the two cases in which I have performed this operation, there has been a history of injury followed by a circumscribed abscess in which was contained the calculus. In one of the cases there were two separate abscess cavities, one of which contained a phosphatic calculus, the other mortar-like phosphatic concretion. A wedge of renal tissue enclosing each of the abscesses was excised, and the cut surfaces brought together by sutures. The result in each case was most gratifying; three years and four years respectively have elapsed since the operations, and the patients remain perfectly well.

In one case in which I found calculous material in cysts in the parenchyma, the kidney was markedly atrophied, and a calculus was impacted in the lower end of the ureter. This complication led me to perform total nephrectomy, but the result was unfavourable, the opposite kidney being also atrophied and the subject of chronic interstitial nephritis. It is this impossibility of knowing that the second kidney, though it secretes urine of fair quality, can secrete it in sufficient quantity, and will continue to secrete at all after nephrectomy of its fellow-organ that makes total extirpation of one kidney so risky in calculous disease, and encourages the substitution of erasion or partial nephrectomy when possible.

The indications for partial nephrectomy are the presence of one or more circumscribed abscesses, which are indicated by a slight rounded prominence, or a soft circumscribed boggy area, or an indurated, somewhat puckered patch on the surface of the kidney. On cutting into such an area pus or purulent urine escapes, and a distinct calculus, or some calculous gritty material, is exposed.

Before excising such an area it should be ascertained that no other calculus exists in the kidney, and that there is no calculus or other obstruction in the ureter, by passing a bougie down to the bladder through a small incision in the wall of the infundibulum. A further digital exploration of the renal parenchyma should be made after removing the wedge of renal tissue, and before inserting the sutures which are to bring the cut surfaces together.

Lumbar incision for removal of a calculus from a fistula or retro-peritoneal abscess.—It will sometimes be possible to remove renal calculi from the body without performing either nephrolithotomy or nephrotomy. This has many times been done where a fistula or a retro-peritoneal abscess has been formed. In such cases it is only necessary to enlarge the fistulous opening, or to cut into the perinephric abscess from the loin. The calculus is then removed from the perinephric tissues, into which it had escaped by the processes of suppuration and ulceration of the kidney. The operation itself is so simple a matter that the contemplation of these cases has led a medical author to remark : “ The cautious surgery of nature is surrounded by safeguards which rarely attend the rougher operations of art.” It will be noted that what is here designated by the term “ nature ” is a prolonged, often painful, and always destructive pathological process which affords a strong contrast to the safety of, and the early stage at which relief can be given by, nephrolithotomy.

THE TECHNIQUE OF THE OPERATION FOR EXPLORING THE KIDNEY AND URETER FOR CALCULUS.

The method to adopt for exploring the kidney and ureter for stone is the following.

In the first place, if there is the least reason for thinking a stone has descended along the ureter, I make a digital examination of the rectum and sound the bladder under an anæsthetic. With the finger of the left hand in the rectum well pressed against the base of the bladder, I pass the beak of the sound across the vesical orifices of the ureters. In the female a similar examination is made of the vagina and bladder; and, if necessary, the urethra is dilated and the interior of the bladder is digitally examined, and inspected by means of Kelly's tubes and the electric light, and the ureters are catheterised from the bladder. But this inspection is rarely needful or helpful, and as a rule is an unnecessary procedure. The kidney to be first explored should be that on the side of the pain. This should be a rule of practice. Though it is true, as I have shown elsewhere,* that the relief of symptoms (pain, fever, nervous disturbance, etc.) may coincidently follow the extraction of a calculus from the opposite organ, still this is no proof that the kidney or ureter on the side complained of is not the one on which the exciting cause of the symptoms is present.

Parietal incision.—The incision I have always employed is a very oblique lumbar one, commencing an inch above and in front of the anterior superior iliac spine, and continued outwards and backwards to the outer edge of the erector spinæ muscle, about a finger's breadth below the last rib (Fig. 122). The length of the incision varies with the figure and degree of stoutness of the individual. More frequently than not it is unnecessary to begin so far forward; and sometimes it is advantageous to continue the skin incision backwards a little over the erector spinæ muscle. The direction of the lumbar incision is, however, always in a line between the points mentioned. When more room is required, a short vertical or slightly curved incision is made upwards from the oblique wound, extending superficially over the twelfth rib. This greatly facilitates deep manipulation, and is a step towards clearing the last rib in the event of the excision of that bone being requisite. Manipulation is also sometimes facilitated by snicking the outer edge of the quadratus lumborum, and even the sheath of the erector spinæ. The latter very rarely needs to be interfered with, and if divided should be sutured at the end of the operation.

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* "Hunterian Lectures," pp. 54–59.

When more room in front is required either for freeing or inspecting the kidney, controlling bleeding in the deep part of the wound, or tracing the ureter, the incision should be carried in a curvilinear way towards Poupart's ligament, and then forward parallel to and an inch above that ligament, as far as the internal abdominal ring, or further. Bleeding points should be controlled as they occur by ligatures, and if the last dorsal or the ilio-hypogastric nerve is in the way, it is best to excise an inch or more of it. After the division of the transversalis fascia, a look-out should be kept for the colon, which frequently bulges into the wound and requires to be held aside

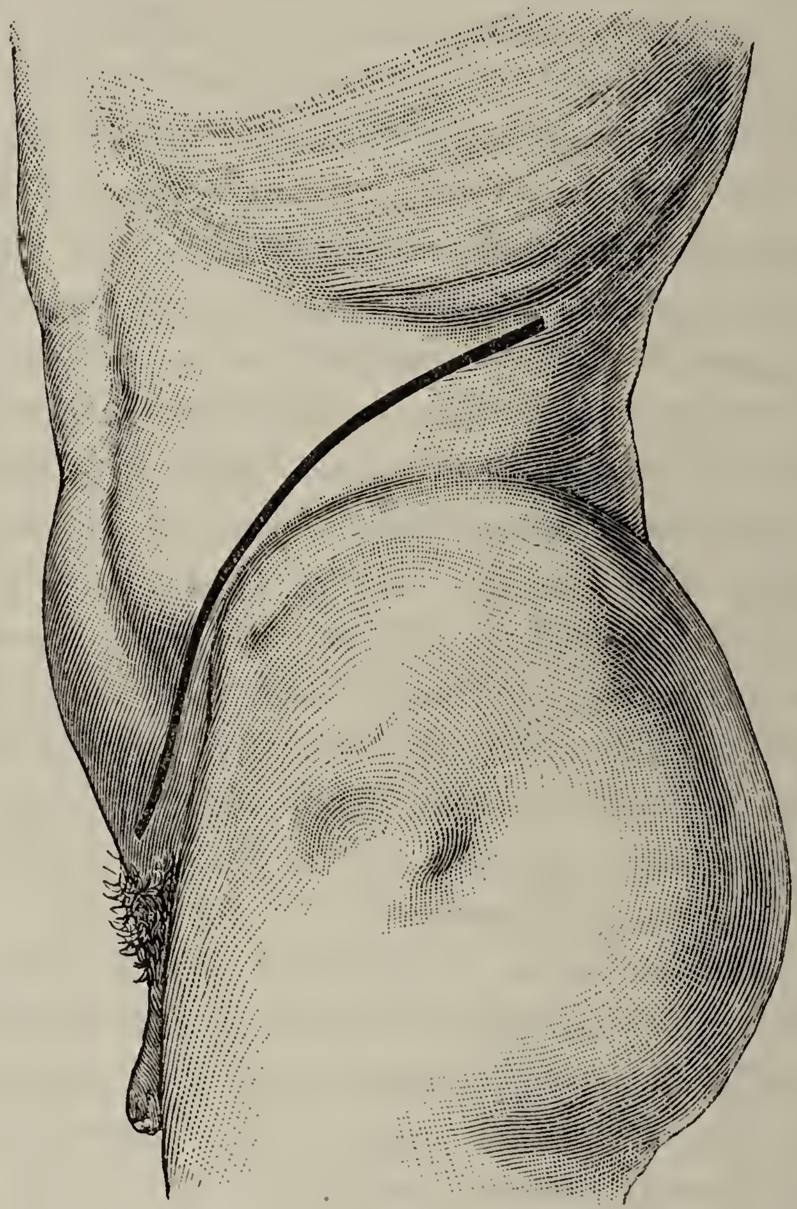

Fig. 122.—Showing the line of the incision for Retro-peritoneal Exploration of the Kidney and Ureter by the *Lumbo-ilio-inguinal* route.

by a broad retractor. With the forefinger, the back of the kidney should now be felt, covered by its loose fibro-cellular investment. By means of two pairs of long forceps this investment is seized and dragged up into the wound, and divided with scissors between the forceps. Then at once bulges out, through the little opening, the fine canary-yellow fat which immediately invests the kidney. Into this opening in the thin fibro-cellular investment the tip of first one, then of the other, index fingers should be inserted, and it and the included fat should be torn open and carefully detached from the kidney.

When the kidney has been fairly reached the index finger should be passed carefully over the whole of the posterior surface of the organ, including its pelvis, and any inequality of surface or increased hardness or resistance at any particular spot should be searched for. During this tactile examination, indeed throughout the whole manipulation of the kidney *in situ,* the abdominal walls of the patient should be well supported by an assistant or well-arranged pillows, so that the kidney may not be pushed forwards by the exploring finger.

Palpation of renal pelvis and upper end of the ureter.—The renal pelvis and upper end of the ureter should be palpated before the kidney has been much disturbed from its position, in order to search for any small calculus, and, if one be present, to prevent it from dropping into the ureter during the act of drawing the kidney on to the surface of the loin.

Kidney should be brought out on to the loin.—When freed from its connections anteriorly, posteriorly, and at both its ends, the kidney should be brought bodily on to the surface of the loin. This in a large number of persons can be done without difficulty and without causing tension of the renal pedicle; but in others, with thick-set trunk and very fat parietes, it is not possible to bring the kidney quite out of the body even when great traction is made upon the pedicle. Forcible pulling upon the pedicle however, must be avoided. I have recently heard of an instance in which a surgeon, disregarding this precaution, pulled the whole kidney forcibly away, tearing through all the structures of the renal pelvis. Though the patient survived the operation, death quickly followed from anuria due to a calculus impacted in the pelvis of the remaining kidney. When, owing to unfavourable physical conditions, the kidney cannot be brought out of the wound, the anterior surface and each of the poles of the organ must be carefully palpated in search of any inequality or induration or softening suggesting the presence of a calculus. Whilst doing this, in order to give counter-resistance to the exploring finger, the kidney should be pressed against the psoas muscle, or be compressed between the finger and thumb, or the patient may be turned on his back, so that the kidney falls into its natural place and thus gets the support of the psoas and quadratus lumborum muscles, whilst the examining finger is left free to test the degree of resistance of the renal substance, without having to use any force to keep the kidney against its counter resistance, namely, the vertebræ and muscles. It is important that the incision should be made amply large enough to allow the surgeon to see clearly the kidney which he is about to incise in the depth of the wound, for unless this be done there is always the risk of wounding the branch of the renal artery or vein which runs over the back of the renal pelvis and enters the parenchyma on the posterior surface of the organ, sometimes far away from the hilum. Moreover, small branches of the renal artery anastomising with the lumbar vessels may be wounded, and should be seen to be ligatured.

Incision of the kidney.—The kidney should now be thoroughly palpated between the fingers and thumb and the presence and exact position of the calculus be made out if possible before cutting into the kidney or the renal pelvis.

Needling the kidney for diagnostic purposes is most unreliable and should be abandoned.

If no calculus is felt, an incision is made into the kidney along its convex border, whilst the finger and thumb of the left hand steady the organ and compress the pedicle. This compression of the pedicle serves a double purpose: (1) it limits hæmorrhage, and (2) it prevents a small calculus, which might drop out of one of the calyces, from falling into the ureter. Through the wound in the kidney the right index finger is introduced, and a careful detailed manipulation is made of every part of the interior of the organ.

The detection of a calculus, if small, often needs a very critical and thorough search with the eye, and by means of the most delicate palpation. Even quite large stones weighing one or two hundred grains may be easily overlooked in a large and sacculated kidney, or be mistaken for condensed sclerosed renal parenchyma. It is only by a careful examination of every portion of the normal organ and of every pouch or recess of an abnormal and sacculated kidney, that this disaster will be avoided. To leave behind only a small fragment of a calculus is to leave a source of continuing irritation and destruction of the kidney, and a nucleus around which another large stone may be formed. The only safeguard is careful palpation through a free incision through the cortex and the requisite division of one tough fibrous septum after another which may be shutting off one pouch or sacculated calyx from the others.

The delivery or extraction of the calculus.—It is, I think, quite immaterial whether a calculus is removed through the parenchyma or infundibulum of the kidney, though I formerly was of opinion that there was less chance of urine escaping, and more chance of quick healing of the wound, when the incision involved the parenchyma only. I believe I was the first to point out that a wound in the secreting structure of the kidney heals more rapidly and readily than one made in the renal pelvis, and I in consequence advocated that the extraction of the stone should be effected through the cortical substance in all cases where this course is feasible. But since employing sutures, which I began to do several years ago, I do not find that wounds in the renal pelvis or ureter heal any the less readily.

In operating upon a sound kidney, I do not hesitate to cut directly down upon a calculus, at whatever point on the surface it may present; still less need one do so in a kidney the cavity of which is pouched and the parenchyma atrophied. When not made along the convexity of the organ the incision should preferably radiate from the hilum; but when the parenchyma is very thin, and a large-branched calculus or several calculi are present, the incision may be made in any direction which gives the greatest facility for extracting the stones.

In calculous pyo-nephrosis I have removed seven stones through as many separate incisions in the thin parenchyma.

The actual extraction of a stone of moderate size, no matter where situated in the kidney, is not a matter of any great difficulty—it can generally be well done by means of the index finger or finger and thumb. It is the small calculi, which can fall or be pushed about in front of the finger from one recess into another, or into the renal pelvis or the ureter, and the very large-branched calculi, which cause the difficulty. There is also more difficulty both in finding and in extracting a calculus from a kidney which cannot be brought on to the loin than one which can be brought well out of the wound. The removal of the small calculi is often facilitated by compressing the renal pelvis between the finger and thumb of the left hand, whilst the extraction is effected by the finger of the right hand or by small suitable forceps. As a rule the finger is far the best, and the calculus when once touched can be retained between the pulp of the finger and the renal substance, and gradually worked along to the aperture in the organ, where it is grasped between finger and thumb and lifted away.

To remove the large-branched calculi an extensive incision of the renal cortex and of the fibrous septa bridling it down should be made. Often it is necessary to press away or peel off the renal tissue which may be intimately adherent to the substance of the calculus. It is best to remove a calculus entire if possible; if it has to be or is accidentally broken, care must be taken to extract every fragment. The smooth round calculi which sometimes fill the renal pelvis have to be, so to speak, skinned, like an orange from its rind. A stone in the kidney should never be, and never requires to be, broken up with a lithotrite, like a stone in the bladder.

After the removal of the calculus, the rest of the kidney can frequently be explored through whatever incision has been employed; but, if not, an incision should be made in the convex border for this purpose.

As long ago as 1829 Gerdy* had advised that the convex border of the kidney should be the incision of election. The advantages, depending on the anatomical arrangement of the blood vessels within the kidney, of an incision along this border are considerable. Moreover, through no other single incision can a complete examination of the cavity and substance of the kidney be so conveniently made.

It is the opinion of Barth † and Tuffier that the extent of parenchymal degeneration about nephrotomy wounds depends chiefly on the size of the vessels divided; and if this be so it is a further reason for making the incision, as Gerdy advised, along the convex margin.

After removing a calculus from the renal pelvis, if the convex border has not been incised, the interior of the kidney should be palpated either through the opening or, if this be too small to admit the finger, then by invaginating the infundibulum.

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* P. N. Gerdy, "Anatomie des Formes Extérieures du Corps Humain" (Paris, 1829). *See* note on p 153 of that work.

† *Archiv f. klin. Chir.* von Langenbeck, 1893, xlvi. 418.

I have taken out some very large stones, weighing between 800 and 1,300 grains, through incisions in the dilated infundibulum large enough to admit readily the tips of two fingers. In such cases an incision in the convexity of the organ for examination purposes is quite unnecessary. In some cases the calculus is so bound down into the renal cavity by thick fibrous bands between the calyces that its extraction would be most difficult through an incision in the renal substance, but very easy through the infundibulum (*see* Figs. 53 and 54, pp. 413 and 414, Vol. I.).

Irrigation of the renal cavity.—When the renal cavity is sacculated and suppurating, it should be freely irrigated with a hot weak solution of Condy's fluid, of perchloride of mercury, or of carbolic acid. In a few instances the calyces have been found packed with a putty-like mass of muco-pus, which was thoroughly cleared out with the finger and little swabs of cotton-wool before irrigating.

The use of sutures on the kidney.—When an incision has been made into the kidney along the convex border, three or four fine silk sutures should transfix the renal tissue about one-sixth of an inch from the edges, so as to hold the cut surfaces together.

I have repeatedly extracted calculi through the anterior as well as through the posterior wall of the renal pelvis without a drop of urine subsequently escaping through the loin wound. This result may be safely expected provided the renal opening has been closed by Lembert sutures passed transversely.

If sutures are not used, it is better, when convenient, to open the anterior rather than the posterior surface, for it stands to reason that the urine as it courses along upon the posterior wall of the duct, when the patient is recumbent, is less likely to escape through an incision in the anterior (*i.e.* in the recumbent position, the upper) wall of the passage. Sutures are not, however, essential to rapid healing. In calculous pyo-nephrosis I have not always used sutures after nephrotomy, and it has often been a matter of surprise how readily some of these cases recover without leaving even a temporary urinary fistula. On the other hand, suppuration in the renal cavity is by no means always a sufficient reason for not using sutures and for not making an attempt to obtain immediate union of the cut surfaces.

Fenger, whose opinion in renal surgery commands attention, does not believe that a kidney with a stone in its pelvis is, in any case, really aseptic, and he warns against the employment of sutures, or making an attempt to secure primary union. He relates a case in support of this contention; but neither the case nor the arguments are convincing. Jacobson has also warned against sutures applied to the renal pelvis.*

How to arrest hæmorrhage.—Though the bleeding is sometimes very free as soon as the renal parenchyma is divided, it is very easily arrested as a rule. As soon as the initial incision from the convex border into the renal cavity is made it is blocked by the examining finger, and bleeding is thereby for the while arrested. After the calculus is delivered, if there is any detritus it should be washed out by hot antiseptic water, and the hot water helps to close the capillary vessels. Whilst the irrigation is proceeding, as well as during the search for and delivery of the stone, if there is hæmorrhage going on the renal pedicle ought to be compressed by the fingers and thumb of the left hand. As soon as the sutures are adjusted and the kidney is returned into the loin, a large hot sponge should follow it, and should be made to compress it gently in its bed against the posterior parietes. Usually this effectually succeeds in arresting all hæmorrhage. In the rare cases in which it does not do so, a carbolised sponge or a compress of iodoform gauze should be packed against the kidney and be left in for some hours. Neither gauze nor even a drain tube should be inserted and left between the cut surfaces of a normal kidney, either for checking hæmorrhage or for drainage. As a hæmostatic, gauze so used is harmful; and such drainage is never required, whilst it causes pain and sometimes colic, and prevents the healing of the wound. In hydro-nephrosis and pyo-nephrosis a drainage tube is necessary, and does not irritate the renal cavity.

Ligatures are never required and should not be employed on the renal parenchyma, nor should torsi-pressure forceps be applied to it; they tend to tear and break up the tissue, and for that reason do not control the hæmorrhage. If the branch of renal artery or vein running over the back of the kidney is bleeding, a ligature is required for it. When the kidney cannot be brought out of the body on to the loin, a long incision in the abdominal parietes should be made, so as to give ample room for immediate manipulation should there be sudden hæmorrhage, as is sometimes the case when the renal parenchyma is incised.

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* Jacobson, *Trans. Clin. Soc.*, vol. xxii., p. 214.

Catheterisation of the ureter from the wound. — Whether or not a calculus be found in the kidney, the ureter should always be catheterised from end to end, to test if its lumen is quite free. If this is not done, a small calculus—say, of one and a half or two grains or more in weight—may be missed, or a stricture, or valve, or an obliquity be left unremoved to cause continuing obstruction.

If the ureteral catheter can be passed readily through the renal cavity by way of the incision in the convex border of the kidney, this should be done; but it is often impossible or troublesome to hit off the orifice of the ureter in this way. When this difficulty exists, the back of the infundibulum should be cleared, and a minute longitudinal incision (to be subsequently closed by a Lembert suture of fine silk) should be made into it with the point of a narrow sharp scalpel, or a pair of sharp-pointed scissors, and through this incision the catheter should be passed. In doing this, care must be used not to mistake the renal vein, or a branch of the vein, for the renal pelvis. Should such an error be made and the vein pricked, bleeding will be readily controlled by pinching up the edges of the tiny wound, and applying a circular ligature. When any doubt arises, the vein will be distinguished from the ureter by the return of blood into it after compressing it.

There is often quite a plexus of fine blood-vessels on the surface of the infundibulum and ureteral wall, which must be avoided if possible.

Extraction of a calculus from the ureter.—If there be a stone in the ureter, the catheter will be obstructed at the point of impaction. In the male, whether this point be in the abdominal or the pelvic course of the ureter, the calculus can be reached and removed retro-peritoneally by prolonging the anterior or lower end of the incision in the direction before mentioned.

In the greater number of cases, when the calculus is not in the kidney it is in the ureter within an inch or two of the infundibulum. In several cases I have pressed a stone upwards out of the ureter, and removed it through an incision in the wall of the renal pelvis; and the same thing has been done by several other operators.

In the female the same procedure answers for the abdominal and first portion of the pelvic course of the ureter; but for the removal of a calculus from the ureter within the broad ligament, especially near the uterus or vagina, the vaginal or sacral route is the best. I have successfully practised the sacral method by means of a straight incision parallel with the lower part of the sacrum and coccyx, and about a finger's breadth from the edge of the upper part of the coccyx, on a woman in whose left ureter a calculus had been impacted for several weeks at a part about one inch and a half behind the vesical orifice of the ureter; and in a second case I removed nine calculi from the lower end of the ureter of a female through the same route. If situated quite at the vesical orifice of the ureter, the calculus can be extracted through the bladder after dilating the urethra and, if needful, slightly incising the ureteral orifice. No attempt should be made to

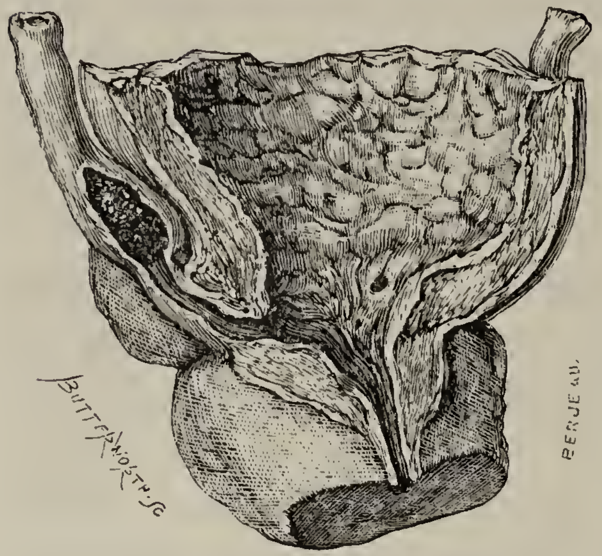

Fig. 123.—Base of the Bladder with a Stone impacted in the Ureter immediately above it. (Westminster Hospital Museum, No. 834.)

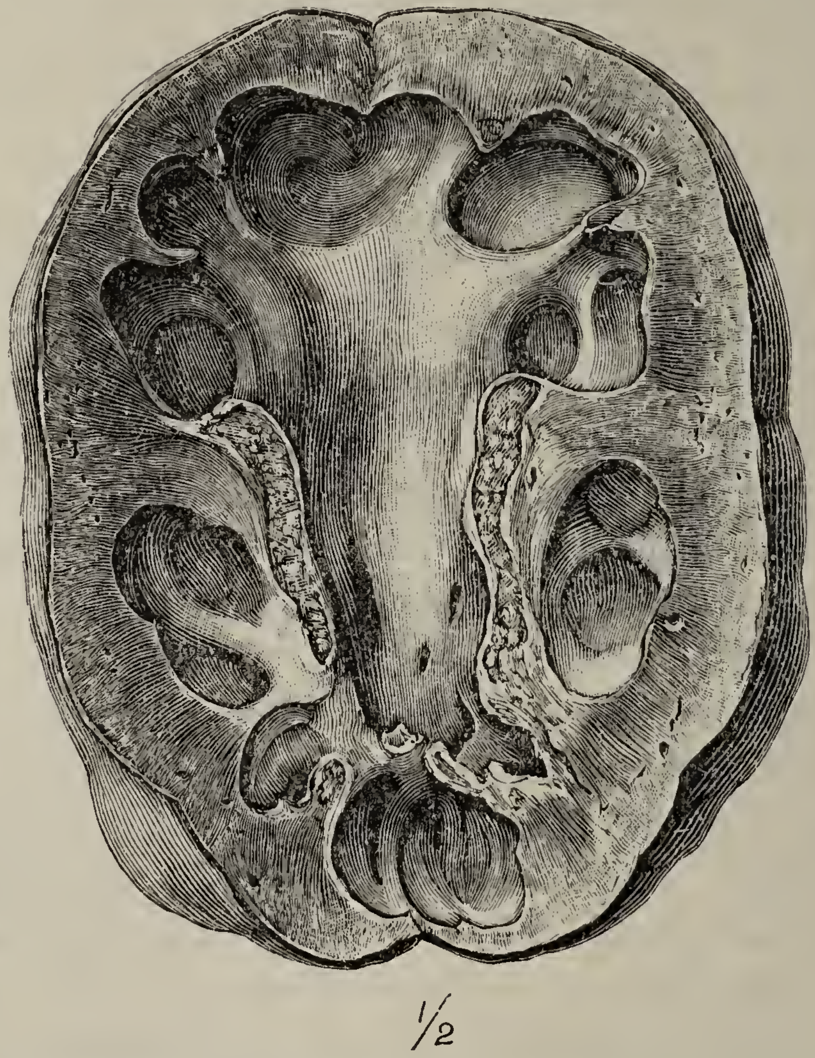

Fig. 124.—Sacculated Kidney caused by a Calculus impacted in the lower end of the Ureter. From the same subject as Fig. 123. (Westminster Hospital Museum, No. 820.)

extract a calculus through the bladder unless it be situated quite at the ureteral opening. A calculus, if it is of fair size, may be felt through the bladder when it is in the ureter just above the point where the duct enters the vesical wall (*see* Figs. 123 and 124). When the calculus is impacted here the sacral route should be employed in the female: it cannot be removed by the vesical route without exposing the patient to the danger of an intra-peritoneal urinary fistula. In a case recorded by Thornton of vesical uretero-lithotomy this accident happened, and the patient died.

In the male the sacral method might also be employed for a stone situated just above the bladder; but the retro-peritoneal inguinal route, through which it is possible to trace the ureter quite up to the point where it enters the vesical wall, is easier of performance, though it does not afford such good drainage as the sacral route.

When the part of the ureter in which the calculus is situated has been reached, the wall of the ureter should be divided by a short longitudinal incision made either upon the calculus or immediately above it. The calculus should then be extruded through this opening. If the stone is impacted below the brim of the pelvis, it should, if possible, be made to retrace its steps, by gentle pressure, till it is brought up into the duct above the pelvic brim. If the ureter is dilated above the stone, and the stone can be readily pushed back into the dilated portion, this should be done, whether the point of impaction is above or below the brim of the pelvis. If there is any other cause of obstruction at the junction of the renal pelvis and ureter, or in the ureter itself, it should be corrected (*see* chapters on "Ureteral Obstruction," p. 446 *et seq.*).

The use of sutures on the ureter.—If the incision is made in the dilated part of the tube it may be closed by one or two Lembert sutures passed across the line of the incision. If the stone be directly cut down upon where it is impacted the tissues of the ureter are likely to be much contused, perhaps ulcerated, owing to the pressure of the calculus, and they may not be in a favourable state for immediate repair, therefore sutures in these cases are of very doubtful utility, or may be even harmful.

The necessity of drainage.—Care should be taken to provide drainage for any urine which may escape through the ureteral wound, otherwise serious mischief in the retro-peritoneal cellular tissue may occur from the too early closure of the external wound.

In every case a drainage-tube should be inserted into the wound around the kidney, but not into the kidney cavity itself. I prefer a tube to iodoform gauze, for the gauze by sucking up and retaining the serum and blood, keeps the surfaces of the wound apart and prevents immediate healing.

Mode of closing the parietal wound.—In closing the parietal wound I transfix the whole of the layers, skin, muscles, and fasciæ with the same sutures, carried by means of Hagedorn's large curved needles. I have for some considerable time abandoned the use of buried sutures for the separate layers of muscles and fasciæ, because I have not found the subsequent scar any stronger, and because the buried sutures sometimes give subsequent trouble, provoking small abscesses, whereby they are discharged perhaps months later.

The length of time required for convalescence, of course, varies. In cases of simple nephrolithotomy patients are often able to sit up on the eleventh or twelfth day, with their wounds healed; and many have returned to their houses between the second and third weeks after the operation. Nephrectomy frequently is as rapidly followed by complete recovery as nephrolithotomy; but if the perinephric tissues have been much affected, suppuration may continue after the kidney has been removed, and complete healing may require some four or five weeks or more. After nephrotomy four or five weeks and more may be required, because as the kidney and the perinephric tissues also are often much disorganised healing takes place for the most part by granulation, though the skin wound may heal by first intention except where the drain-tube emerges.

Dr. McBurney,* in a case of **suppression of urine after operation for removal** of renal calculus, gave relief by a saline infusion. There were indications of loss of blood, and the suppression of urine threatened to end fatally. A quart of the solution was injected into a vein of the arm. Within twenty-four hours thirty-four ounces of urine were passed, and on the following day seventy ounces; the patient steadily improved. It is interesting in this connection to note that Dr. Lilienthal had a similar experience in a case of suppression after resection of a hernia ; and Dickinson has reported a case in which benefit ensued after similar treatment for a case of embolic coma.

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* *Annals of Surgery*, vol. xxii. (1895).

Summary.—The conclusions at which I have arrived respecting the treatment of renal calculus are the following :—

1. That the aim should be to extend the application of nephrolithotomy and ureterotomy, and thereby restrict the necessity for nephrotomy and nephrectomy.

2. That more frequently than not, an exploratory operation whereby no calculus is discovered is not in reality a "negative exploration," because so many *curable* morbid conditions which mimic renal calculus are discoverable only by an exposure of the kidney.

3. That the theory that a stone in one kidney, whether that kidney is itself painful or not, reflects or transmits pain to the opposite kidney, is quite unproven ; that it is a dangerous theory, calculated to lead to very erroneous practice ; and that the surgical principle with regard to exploratory operations should be *that with pain, paroxysmal or continuous, on one side only, the kidney on the painful side* should be explored.

4. That nephrectomy for calculous conditions is very rarely called for, and should be done only in most exceptional cases. Nephrotomy for calculous **pyo-nephrosis** is the proper operation —at any rate as a primary operation—because of the frequency of double calculous disease. My experience has shown me that kidneys from which stones weighing 830 grs. and 1,300 grs. have been removed, may be sufficient to maintain life during the blocking or suspended action of the opposite organ.

5. That nephrectomy of a greatly disorganised kidney, whilst the opposite organ is occupied by calculus, is almost certainly followed by death ; whereas nephrectomy, after the opposite kidney has been freed of stone, and allowed some time to recover, will probably be followed by recovery from the operation and possibly by very good health subsequently.

6. That when renal calculus causes reflected or transferred vesical or ovarian pain the removal of the calculus will be followed by complete cure of the bladder or ovarian symptoms.

7. That in some cases renal calculous conditions are attended by very remarkable nervous symptoms, sometimes with, sometimes without high temperature, and that information as to the cause of these symptoms is needed.

8. That an unsuspected renal calculus is a source of very real

danger; and when its presence is disclosed, whether by accident or by the systematic examination of the urine, we should recommend its immediate removal, regardless of the fact that it is not causing pain, unless the general condition of the patient contra-indicates an operation.

9. That quiescent calculus is as dangerous as unsuspected calculus, and ought to be removed by operation.

10. That the hitherto accepted teaching, that a renal calculus, if causing mild symptoms extending over a lengthened period, or attacks of severe colic of only recent occurrence, should be treated on the expectant plan, ought for the most part to be discarded as unsound in theory and dangerous in practice.

11. That the same principle should be applied to renal calculus which has long been the rule in regard to vesical calculus, namely, when suspected it should be searched for, when known to exist removed, without waiting in the hope that it may become encysted or spontaneously expelled.

12. That the very low mortality of nephrolithotomy puts this operation upon the same footing for renal calculus as lithotrity in the most experienced hands for vesical calculus.

CHAPTER XXVI.

CALCULOUS ANURIA.

Calculous anuria is the gravest and most fatal of the many serious complications of renal lithiasis. Special attention was given to it in 1872 by Sir William Roberts in the second edition of his classical work on "Urinary and Renal Diseases" (p. 23 *et seq.*); and in 1881 an exhaustive thesis on anuria by Pierre Merklen was published in Paris; but neither in this nor in Roberts's book is the subject of the surgical treatment of calculous anuria considered.

In his 1885 edition Sir William Roberts, it is true, says in a footnote: "Lately it has been recommended to open the ureter or pelvis of the kidney above the obstruction, and so establish a permanent urinary fistula," but though antispasmodics and a variety of mechanical means are recommended, and diuretics are rightly condemned, still surgical aid was not seriously discussed by either Roberts or Merklen.

Even at the present time the principle of the operative treatment of calculous suppression of urine is either imperfectly known or improperly appreciated by the profession in this country; because operations are certainly neither sufficiently early nor sufficiently often performed.

It was Gigon of Angoulême who in 1856 first suggested ureterotomy and the establishment of a lumbar fistula in a case of this sort.

Guermonprez in 1870 reported the first case operated upon. The next operation was performed by Bardenheuer in 1882. The patient was a female, aged thirty-seven, with anuria of forty-eight hours' standing. The lumbar method was adopted, and a calculus was found in the upper orifice of the ureter. The stone was pushed back into the renal pelvis and removed through an incision in its wall.*

In 1883 Bennett May and Clement Lucas † advocated nephrotomy and the establishment of a permanent fistula in cases of anuria when one kidney is absent or disabled and the ureter of the other kidney becomes blocked by a calculus. This is Gigon's suggestion over again.

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* *Centralblatt für Chirurgie*, March, 1882.

† *Brit. Med. Journ.*, vol. ii., 1883.

In 1884, in an article on "Calculus Impacted in the Ureter, and the Feasibility of Removing it by Surgical Operation,"* I related a case in which for the first time an attempt was made to remove a stone from the lower end of the ureter for the cure of calculous anuria. The calculus was detected in the intravesical extremity of the ureter, and I endeavoured to remove it through the bladder after dilating the female urethra. But the attempt was ineffectual from want of a suitable cutting instrument.

Although Emmet had shown in 1879 that a calculus could be successfully removed through the roof of the vagina without opening the peritoneum, and had also removed a stone from the ureter after opening the bladder, it had not then been ascertained that the pelvic portion of the ureter, *i.e.* the part between the brim of the true pelvis and the bladder, could be safely reached and incised by any other route, without running the risk of causing intra-peritoneal urinary extravasation.

In 1884 it seemed improbable that a calculus could be removed from the intra-pelvic portion of the ureter without opening the peritoneal cavity, but I recommended, in the article referred to, that the intra-vesical end of the ureter, in both sexes, and as much of the duct as could be reached when exploring the kidney through the loin (and that is practically the whole of the abdominal portion of the ureter), should be directly attacked in cases of calculus impacted in the ureter.

It has, however, since been shown that a calculus can be successfully removed from the intra-pelvic portion of the ureter without opening the peritoneum, and therefore without exposing the patient to the risk of urine escaping into the peritoneal cavity.

In 1885 Israel, as well as Bardenheuer, in Germany, successfully treated anuria by extracting calculi from the infundibulum of the adjacent part of the ureter by means of the lumbar incision. In France Mollière of Lyons, in 1885, was the first who operated for calculous anuria. He punctured the infundibulum through the renal parenchyma with the thermo-cautery on the fifth day of anuria, but though the anuria ceased the patient died on the third day after the operation.

* *American Journal of Med. Sciences*, p. 458.

Since 1885 three or four excellent theses on this subject have appeared in France by Legueu, Donnadieu, Glantenay, and Vailhen; and in England, though nothing bearing generally on the surgical treatment of calculous anuria has been published, some brilliantly successful operations by the lumbar route have been reported, notably by Clement Lucas, Ralfe and Godlee, and Kirkham, who were amongst the first English surgeons to operate in these cases. Ceci, in 1887, in a case of anuria, removed several stones from the ureter through the rectum; and during the last year I have extracted by the sacral route a calculus situated about one and a half or two inches above the vesical extremity of the left ureter of a woman who, without having complete suppression, evinced distinct symptoms of partial anuria on several occasions during the few weeks of the impaction of the stone.

Etiology.—Calculous anuria is the term used to denote suppression of urine, which results from the presence of a stone in the kidney or ureter.

The suppression may arise from a small calculus slipping into the ureter and blocking its lumen, while the kidney itself is almost normal in structure; or, on the other hand, it may be the result of a total destruction of the renal secreting substance which has gradually taken place, giving rise to the "anuria calculeuse toxine" of Legueu. Between these two extremes there are many gradations, and the two conditions, viz. destruction of kidney substance and blocking of the ureter, may of course exist at the same time.

The most important clinical feature of a case of calculous anuria is the fact that it denotes that the patient possesses only one functionally active kidney, the other being either absent or destroyed by previous disease. The only exceptions to this rule are those cases in which the shock arising from the sudden blocking of the ureter gives rise to a reflex suppression in the opposite kidney, which, although functionally active, has suffered from previous disease, and so has become more susceptible to any nervous influences. Such cases, however, in which the suppression is prolonged for any length of time must be very rare; and indeed their very existence is questioned by some authorities, and the possibility of their occurrence, although to be kept in mind, should not be allowed to weigh against operative measures in any individual case where the symptoms seem to demand them.

In the most typical pathological condition of calculous anuria there is occlusion of both ureters by calculi (*see* Figs. 125, 126, and 127). This condition is, however, certainly an uncommon one, and in most cases the anuria is the result of an obstruction to one ureter, the kidney on the opposite side having been previously destroyed, either by calculus or some other disease.

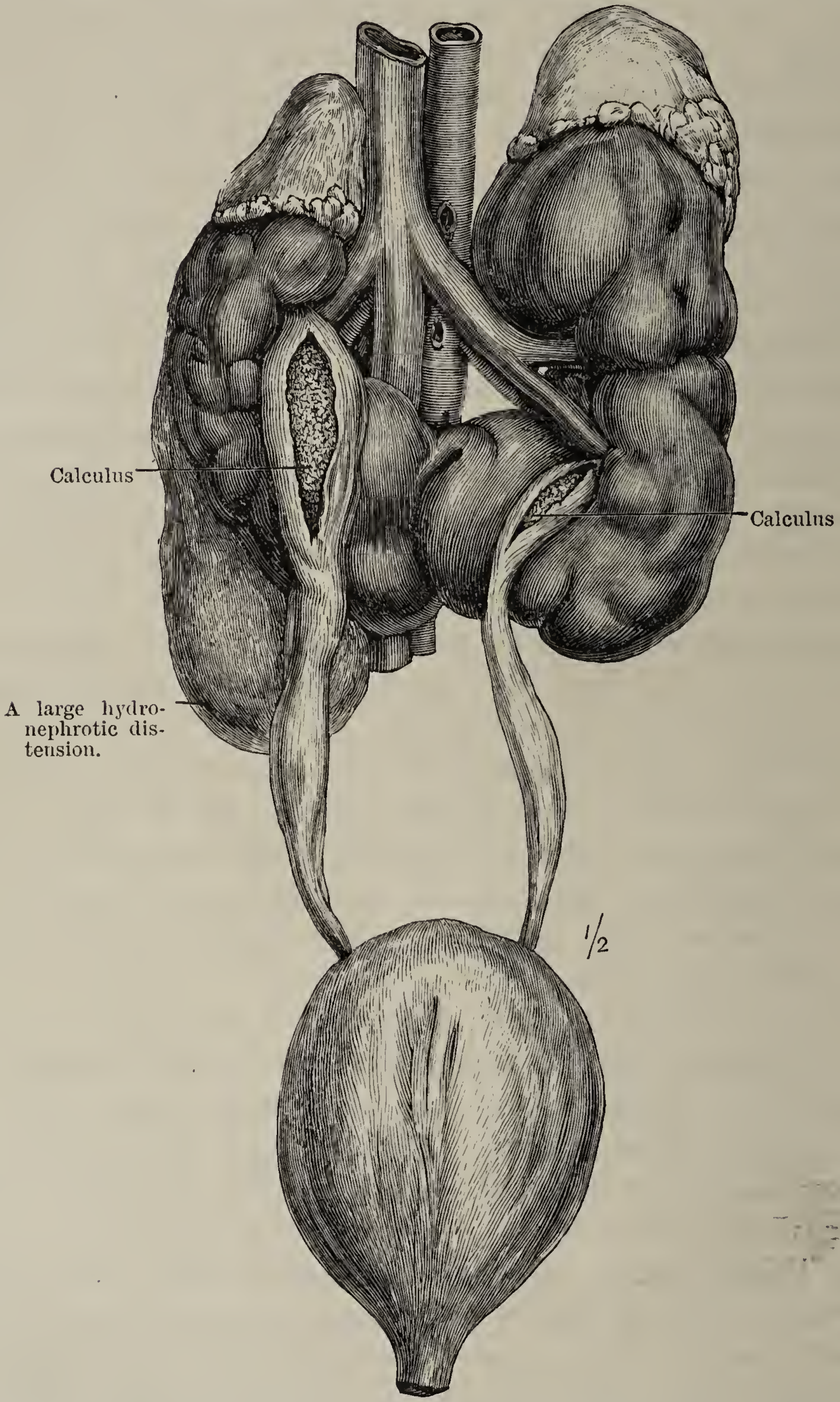

Fig. 125.—Horse-shoe Kidney with a Calculus in each Ureter. Post-mortem specimen. (Middlesex Hospital Museum.)

A person with only one functionally active kidney may thus go about apparently healthy for years, and then suddenly the ureter or pelvis of this kidney may become obstructed by a small stone which has hitherto lain unsuspected in the renal substance; a complete suppression of urine will be the immediate result and unless relieved by a surgical operation, will almost invariably go on to a fatal termination.

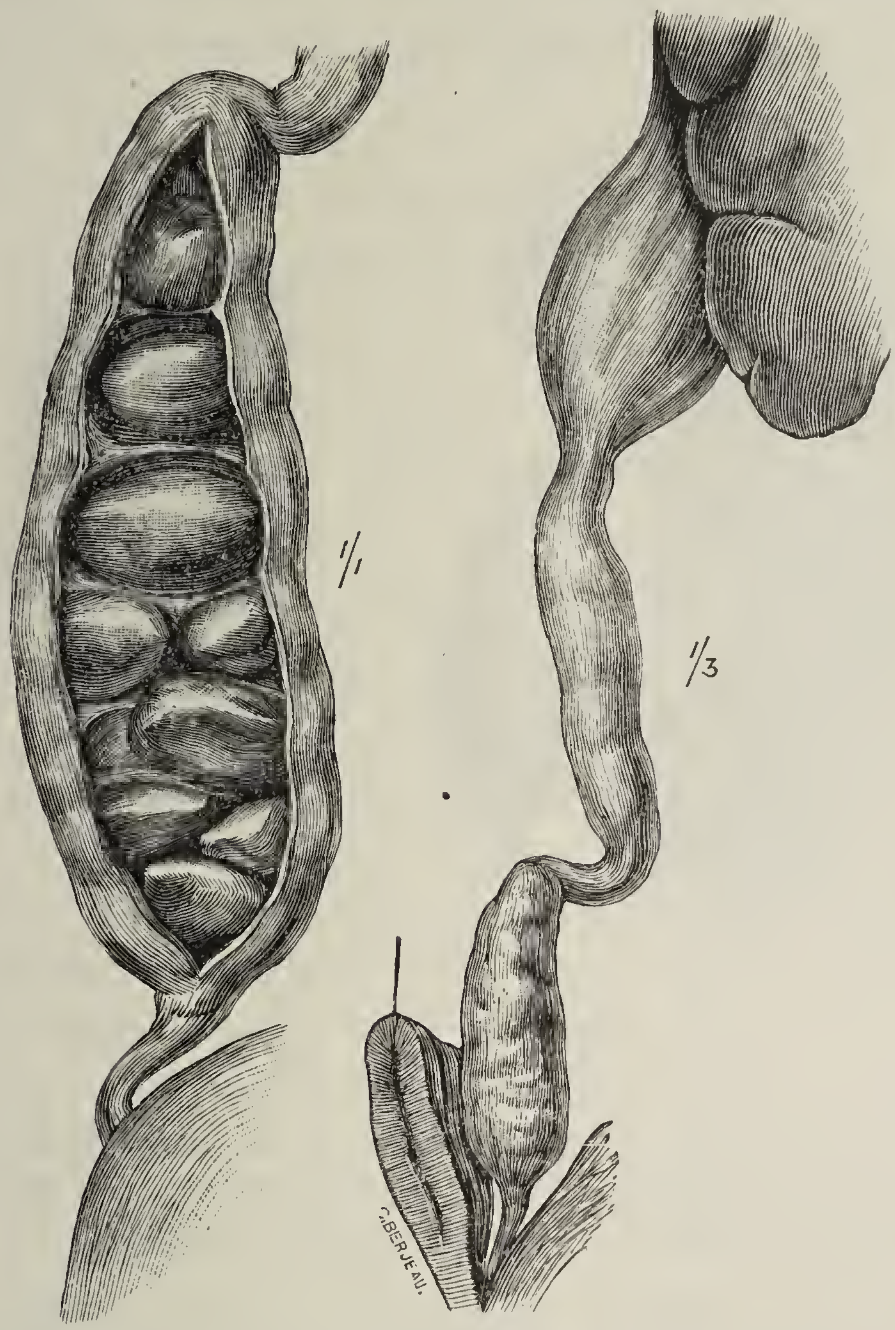

Fig. 126.—Ureters packed with Calculi. The calculi in the ureter laid open are represented in the drawing arranged precisely as they were found after death. (Middlesex Hospital Museum.)

Anuria often affects persons in robust health, and may be sudden and complete in its onset. It is then due to the cessation of function of a kidney which has undergone compensatory hypertrophy, and which up to the moment of obstruction had been secreting the whole or the chief part of the urine.

Calculous anuria is, in the first place, a failure of excretion due to obstruction, but it rapidly becomes a failure of secretion owing (1) to intrarenal pressure on the obstructed side, and (2) to reno- or uretero-renal reflex suppression in the opposite kidney if the latter has taken any share in the secretion up to the time of the commencement of the anuria.

It must be distinguished from the dysuria, or oliguria, which frequently (though not invariably) accompanies renal colic, and passes off with the attack of pain. This dysuria is attributable to the reflex influence upon the vaso-constrictor nerves of the kidneys excited by the irritation of the mucous membrane of the renal pelvis, or by the stretching of the ureteral walls, and not to any mechanical obstruction to the flow of urine.

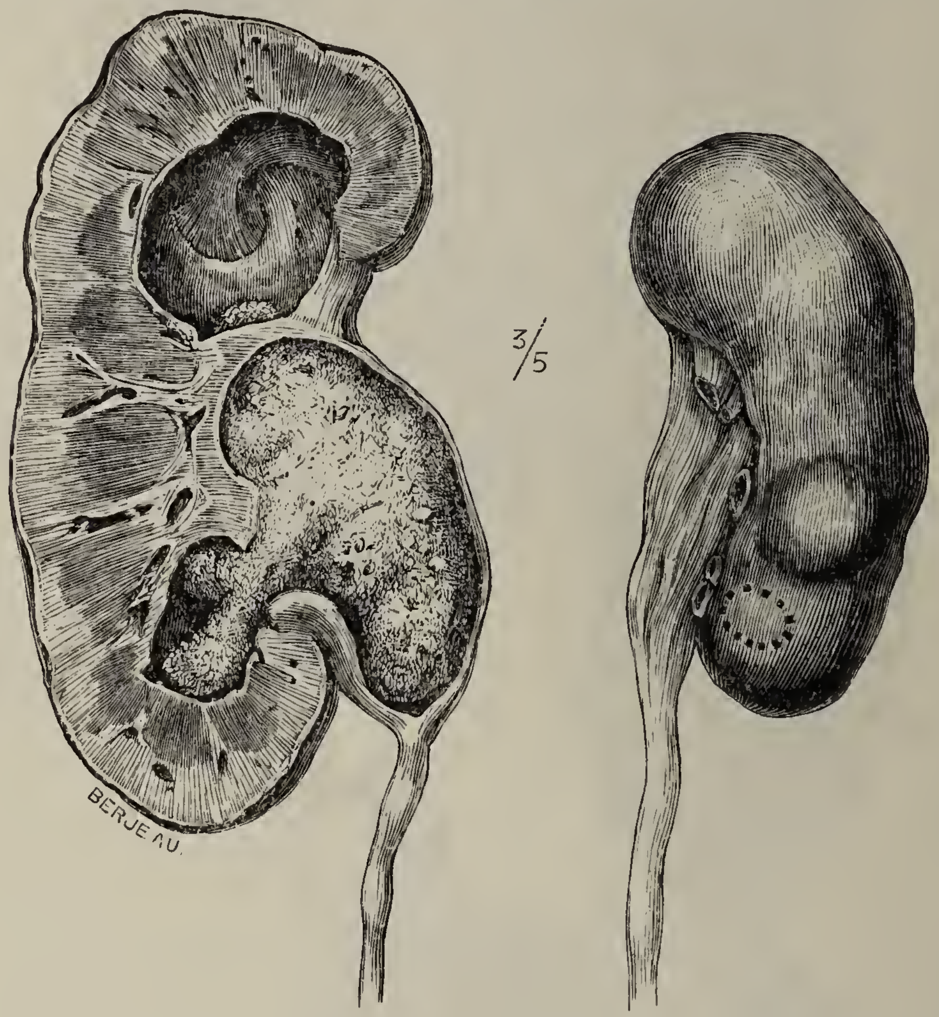

Fig. 127.—The two Kidneys of the same person, each blocked with a Calculus. The one first affected is atrophied, the other has been hypertrophied, and is becoming hydro-nephrotic. (Middlesex Hospital Museum.)

The statements which follow are based on two sets of cases which I collected—namely, forty-eight cases not operated upon and forty-nine operated upon. In fifty-six cases the situation of the calculi were noted to be as follows:—

1. In the renal pelvis and blocking the upper orifice of the ureter in seven cases. In four of these, both ureters were blocked at the renal orifices.

2. In the upper end of the ureter in thirty cases. Both ureters were blocked in five of these cases. In three there was another stone impacted lower down (two in the mid part and one near the bladder).

3. In the middle portion of the ureter in seven cases. In one case both ureters were blocked, and in two others there was a second blockage by a calculus higher up.

4. In the lower end of the ureter in ten cases. In one of these there was an impacted stone also higher up, in three of them both ureters were obstructed.

5. In two cases complete suppression was caused by obstruction of both kidneys by a large vesical calculus (specimen in Middlesex Hospital Museum, and Amoden's case recorded in the *Bulletins de la Société Anatomique,* 1875).

There are two classes of calculous anurics—the gouty, fat, and apparently robust adult past middle age; and the thin, nervous and dyspeptic person.

Anuria may occur at any age and in either sex; it is more frequent in males of thirty-five years and upwards, and more especially in elderly men. Instances of children, and even infants at the breast, dying of convulsions from calculous suppression have been recorded (Rayer). Out of eighty-one cases collected in which the sex and age are stated, there were fifty-four males and twenty-seven females. Forty-three out of the eighty-one occurred in persons between forty and sixty; fifteen in persons over sixty years; nineteen in persons between twenty and forty; one before the tenth year, and three between ten and twenty. The youngest was aged six and the oldest eighty.

The condition, though rare in children, is by no means unknown. Rayer mentions a case recorded by Harder of a male infant who suffered from an attack of renal colic at the early age of three months, and when two years old died in convulsions from calculous anuria; a post-mortem examination showed *sabulous* deposit in the renal tissue and an oblong calculus at the entrance of one ureter.

Rayer also mentions the cases of two infants at the breast, aged two days and eight days, who died in convulsions, which were the result of small calculi; in one of these children there were numerous calculi in the kidneys and in the other there was a calculus in the right ureter. I have myself recently had an opportunity of examining the urinary organs of a child aged one year and seven months who died from calculous anuria.* Up to the age of fifteen months there was nothing of importance in the child's history, but at that age it screamed every time it attempted to pass water over a period of one day and one night; a bottle of medicine was obtained from a chemist and the attack was said to have passed off. No history could be obtained of the passage of blood or high-coloured urine. Nothing else of note occurred until four days before the death of the child, when complete suppression of urine suddenly set in and remained until death took place on the fourth day. A post-mortem examination showed that both ureters were blocked by calculi; in the right ureter a stone was impacted close to its termination at the bladder, and it was no doubt the passage of this stone which gave rise to the acute attack of pain which occurred when the child was fifteen months old. On the left side a stone was found in the renal pelvis completely blocking the opening of the ureter. The calyces of both kidneys were somewhat distended and the kidneys themselves were enlarged.

Another very interesting point connected with this case was the commencing formation of a valve in the wall of the ureter at the site of the impacted stone on the right side. The mucous membrane of this area was very congested, and two semi-lunar folds situated side by side projected into the lumen of the tube, forming a decided obstruction, and in their appearance and shape looking very like the semi-lunar valves of the aorta. The formation of such valve-like conditions is very important and is more fully considered in the chapter on Ureteritis and Peri-ureteritis (*post*, p. 391).

Much importance ought to be attached to the antecedent history of patients who become the subjects of suppression of urine from ureteral obstruction. Commonly they have had several previous attacks of renal colic, or of lumbar pains, followed by the discharge of gravel or small stones, months or even years before the attack in which the anuria begins. But cases have occurred of sudden suppression of urine from obstruction by a calculus without a previous attack of any kind. In such cases both kidneys have been simultaneously obstructed, or one kidney has been destroyed by disease of another kind, or has been congenitally absent or abnormal.

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* I am indebted to my friend and former house-surgeon, Mr. F. B. Mudd, for this very interesting specimen.

Calculous anuria is often determined, or immediately induced, by fatigue; a drive, or some other shaking movement, such as jumping from an omnibus, violent coughing, running rapidly, are some of the causes in my own cases which started the descent of the calculi from the kidney into the ureter.

Symptoms.—The symptoms of calculous anuria are not simply those of uræmia. They also differ in their mode of onset and in their character from some other forms of obstructive anuria, such as anuria from cancer of the uterus; from the pressure of abdominal tumours; and from torsion, curves, or stricture of the ureter; as well as from toxic, reflex, and hysterical and other non-obstructive forms of anuria.

When the uræmic symptoms set in they exhibit marked differences from the uræmia of lardaceous disease, of Bright's disease, and of other forms of nephritis.

Though in rare instances the onset is insidious, pain in the region of the kidney last involved is almost invariably experienced at the commencement of the suppression. The pain may continue throughout the anuria, but more commonly it is temporary, lasting only a day or two, or less, and then subsiding. Less frequently the first symptom is a dull and continuous aching in the lumbar region, with or without pains radiating along the course of the ureter. In very exceptional cases the anuria has come on without pain on either side, and without the history of previous attacks of renal colic; or the patient has quite forgotten on which side the previous attacks of colic were. These, fortunately rare, are the cases in which the surgeon may have no guide as to the kidney upon which to operate.

With the pain there may be troubles of micturition, such as continual desire to pass water, though not a drop of urine may be in the bladder; or the urine is passed with difficulty, and sometimes only in drops or teaspoonfuls. Or, on the contrary, there may be polyuria, the urine being pale and of low density, and showing evidence of imperfect renal function. In other cases the anuria is intermittent, ceasing after some hours or a few days to reappear and become definitely established.

Calculous anuria may be complete or incomplete. In the complete suppression the bladder is quite empty, or if not empty it contains but a few teaspoonfuls of bloody urine. In the incomplete form the anuria is intermittent, but progressive, and interrupted by discharges of urine, insufficient to satisfy the requirements of the system, but sufficient to retard the fatal termination of the disease. When the working kidney is hydro-nephrotic the uræmic condition may be deferred for a longer time than otherwise, even if there are no polyuric intermissions.

Calculous anuria, once established, may last many days without causing any symptoms of uræmia. This is perhaps its most striking feature, which it shares with other forms of obstructive anuria, as distinct from the non-obstructive forms. Even when the suppression is complete, seven, eight, or ten days may elapse before the symptoms of uræmia appear, and sometimes death occurs without any of the characteristic symptoms of uræmic poisoning arising at all. When the uræmic phenomena supervene after a longer or shorter time, death follows rapidly, or at any rate within a day or two. Thus it happens that authors have come to distinguish two stages in the progress of calculous anuria, namely (1) the silent or tolerant period; and (2) the uræmic period. But it is important to remember that death may occur as just mentioned without the second or uræmic period supervening.

(1) **Symptoms of the tolerant stage.**—In the period of tolerance, the patient, though he may not pass a single drop of urine for several days, may yet walk about, eat, and do mental work with all the appearance of good health. This fact must never be forgotten, if a serious mistake in diagnosis and prognosis is to be avoided. It is, however, all the more likely to escape notice because it is so opposed to the course of suppression due to non-obstructive causes.

In the non-obstructive forms of suppression, *e.g.* in chronic, sub-acute, and acute forms of Bright's disease; in suppression from shock or collapse, as after severe internal injury, and in the algide stage of cholera or yellow fever; in all forms of inflammation and fever; and in the suppression of urine after slight operations on the urethra or bladder, death may occur within twelve or twenty-four hours. In these cases there will be symptoms of uræmic poisoning, but death would seem to be too rapid to be explained simply by the non-elimination of urinary excreta. Moreover, if the suppression ceases, the return of the secretion is gradual, and the first quantities of urine secreted are scanty, albuminous, and perhaps bloody.

On the other hand, in the calculous cases the suppression of urine may last for days, and if the anuria should cease temporarily, or permanently, free secretion is resumed; the urine passed is of low specific gravity, and pale in colour; and though it may possibly contain blood, it is defective in the ordinary urinary constituents.

The lumbar or nephritic pain which ushers in obstructive anuria often ceases as soon as the pressure of the pent-up urine in the renal cavity and the pressure of the blood within the renal vessels are equalised. It is only in exceptional cases, where previous intermittent or imperfect obstruction has induced a condition of hydro-nephrosis in the kidney involved, that anuria is accompanied by persisting pain.

Another striking feature is that anuria caused by calculus is rarely quite complete from the beginning to the end of the illness. At different intervals, some drops, ounces, or, it may be, even pints of urine—pale, limpid, of low specific gravity, poor in urea, in urinary salts, and in the urinary colouring matter—are voided.

"The characters of this urine," says Merklen, "are so decisive that they strike the patient as much as the doctor. Its density rarely exceeds 1006–1008; it is only rarely albuminous, but sometimes it contains blood and epithelial casts. Owing to its indifferent excrementitious character these discharges of urine have but slight influence on the final result; the total amount of urea eliminated by a patient throughout an anuric crisis being insignificant."

Of course, in cases of calculous pyelitis, or disorganisation of one or both kidneys, the urine may also contain pus as well as blood, and renal casts and epithelium, and yet be deficient in the normal urinary solids.

In certain cases, as in those recorded by Paget and Weber, polyuria occurs, and retards the appearance of uræmic phenomena as well as the fatal termination, which, however, at length arrives just the same. In Paget's case polyuria occurred on the thirteenth day, and death was deferred till the twenty-second day. In Weber's case a succession of remissions of polyuria took place, and the fatal result was not reached till the thirtieth day.

In one of Roberts' cases the patient lived fifteen days. Tenneson* reported a fatal case in which the suppression lasted fifteen days. Dr. Ernst Bischoff reported the case of a man aged fifty-eight who for fourteen years had suffered from gout and lithiasis; he had had repeated temporary suppression for several days together; then twenty-three days of anuria, with two very slight intermissions on the fifth and fourteenth days, attended by œdema, fever, and aphthous stomatitis and very high temperature. The post-mortem showed a very small left kidney, but in a state tending towards compensatory hypertrophy, with calculi in both ureters and in the left renal pelvis.

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* *Gaz. Hebdom.* (1879).

In one of my own cases there were two periods of complete anuria for forty-eight hours or more, with intermissions, during which there was a more or less free secretion for eleven days; then three days when the daily secretion was ten ounces, six and a half ounces, and one ounce respectively; and lastly, four days of complete suppression preceding death on the eighteenth day from the onset of the anuria.

In the stage of tolerance, though the general health is at first but slightly if at all affected, some symptoms arise after three, four, or five days referrible to the digestive organs, such as eructations, nausea, constipation, flatulence, and a white-furred tongue; or referrible to the nervous system, such as mental depression, a sense of lassitude, and disturbed sleep or actual sleeplessness. But these symptoms are not constant, and if they exist, may be so slight as to pass unnoticed, especially if the anuria should terminate spontaneously.

In some cases during this stage the desire to urinate is strong and persistent. There may be a sense of weight and fulness about the bladder, and tingling at the end of the penis, which lead the patient to believe he is unable to empty a distended bladder, and to seek relief by catheter for supposed retention, when the real condition is suppression.

Symptoms of the tolerant stage when hydro-nephrosis is associated with anuria.—When the working kidney is hydro-nephrotic, patients with calculous anuria may escape uræmic accidents for a much longer time than others, without having polyuric remissions. Thus in a fatal case of a man aged sixty-four recorded by Rayer,* with an enormous hydro-nephrosis, the anuria lasted twenty-five days, with only a slight remission on the tenth day. James Russell published a case of anuria lasting twenty days, which terminated by the discharge of ten litres of urine in twenty-four hours; but a year later the patient died, and at the post-mortem examination there was discovered double hydro-nephrosis with calculi in the pelvis of each kidney.

Roberts cites a case of calculous anuria of ten days' duration, with an increasing tumour in the left iliac fossa; recovery followed a veritable urinary crisis coincident with the disappearance of the tumour.

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* *Mal. des Reins*, t. iii. p. 490.

A hydro-nephrotic tumour, although exceptional in calculous anuria, should be carefully looked for in every case. Its presence indicates the continuation of urinary secretion—imperfect certainly, but still sufficient to prolong life,—and therefore forms an important element in prognosis.

Hydro-nephrosis occurs only when anuria is repeated on many occasions, for a brief period only, or in an incomplete manner: that is to say, when the obstruction is intermittent, or imperfect and progressive. In one of my cases complete anuria, accompanied with pain and a tumour in the left renal region, occurred on many occasions, lasting two or three days at a time. The right kidney was packed with calculi, calculi being felt to grate on one another, and the left kidney, which had undergone compensatory hypertrophy, was in an early stage of hydro-nephrosis and contained a single round calculus the size of a small cherry, which was freely movable in the renal cavity. The left ureter was unobstructed, and normal throughout.

In Wilcox's case there were many crises of nephritic colic with anuria, terminated by diuresis, and death ensued at last from rupture of a hydro-nephrotic kidney after six days of anuria.

It is in cases of anuric hydro-nephrosis such as this, and also those of Rayer, Weber, James Russell, and Roberts, in which marked polyuria announced the re-establishment of the secretion of the urine, that operative treatment is most likely to succeed. An early operation in such cases would lead to the discovery and removal of the cause of the hydro-nephrosis, as well as of the anuria, and would save the kidney from progressive degeneration, and the patient from fatal suppression of urine.

The fact that the opposite kidney is functionless and destroyed is an additional reason for operating, not a contra-indication for so doing, as it is too often considered to be. It was so regarded in the case of my patient just referred to, whose left kidney was first relieved of its calculus, and whose right kidney was afterwards operated upon for stone, with a result that was all that could be desired.

(2) **Symptoms of the uræmic stage.**—At a variable period the second or uræmic stage sets in. When the anuria is complete this period arrives mostly about the seventh or eighth day. For a time no doubt the poisoned state of the circulation

is relieved by the supplementary elimination through the skin, lungs, and intestinal mucous membrane. But sooner or later these organs are insufficient for the task, and themselves become vitiated by the unaccustomed functions they are called upon to perform; then the blood becomes surcharged, and in turn the nervous system comes under the influence of the uneliminated poison. But why this effect is so much more tardily produced in calculous anuria than in non-obstructive uræmia is not known.

The symptoms of the uræmic stage may be summarised under three groups (*a*) the circulatory, (*b*) those connected with elimination, and (*c*) those of poisoning.

(*a*) The pulse is slow and full and later becomes irregular. Epistaxis in one case was very abundant; œdema about the malleoli and even a true anasarca—the result of venous stasis, not of albuminuria—have been observed in a few cases by Sir William Roberts, Russell, Ernst Bischoff, Tenneson, and Merklen. The temperature is low, as in all forms of uræmia, namely from 97° to 97·6° F.

(*b*) Profuse perspirations may occur, but if so they are suppressed in the last day or two of life. The older writers state that the sweat has the odour of urine; but modern writers, following Roberts, dispute this. Roberts, indeed, goes further, for he says (4th ed., p. 34), "there is never any ammoniacal or urinous odour from the breath or skin, nor from the body after death." In one of my cases, in which there had been suppression for nine days, Mr. Steedman wrote me that about twelve hours before death the patient's "extremities became cold and clammy, her face swollen, and the breath strongly ammoniacal. The body began to be offensive a few hours after death."

In the absence of sweats, cases of itching of the skin, pruriginous eruptions, and erysipelatous swelling of the whole body are quoted by Rayer; profuse salivation is noted by Weber; blood-stained expectoration by Foissac and Paget.

But more important than the foregoing symptoms is *vomiting*. This is copious and due to gastric irritability rather than to supplementary elimination. It is a symptom of bad omen, which precedes and accompanies the uræmic nervous phenomena. Obstinate constipation and meteorism are common symptoms. Meteorism may be particularly troublesome. Sometimes there is a veritable intestinal paralysis. Diarrhœa, so common and marked a symptom in some cases of uræmia from lardaceous disease, is very exceptional in calculous anuria.

(*c*) Contraction of the pupils and muscular tremors are the two most marked symptoms of the poisoning stage. The great general disturbances which acute nephritis and Bright's disease cause do not occur. The dominant feature of fatal anuria is complete depression of body and mind. The intelligence may be perfect to the last moment, but more often it becomes after a while impaired, the patient being in a state of semi-sleep, from which, however, he is easily roused. Occasionally delirium or hallucinations occur. Incessant restlessness and an overpowering feeling of heaviness and general fatigue are, when they exist, the immediate precursors of death. The limbs instead of being affected by muscular twitchings and agitations may be benumbed or as if paralysed. The temperature falls lower with the progress of the disease. The respiration becomes slow and sighing and irregular, and the patient dies with symptoms of respiratory failure. Or the patient may die of heart failure without a convulsion, without coma; occasionally death is caused by coma or a convulsive crisis; and sometimes by an attack of suffocation two or three days after the commencement of the uræmia.

Prognosis.—The usual termination of calculous anuria when left to itself is death about the tenth or eleventh day. If, however, the suppression is interrupted by intermittent polyuria, whether hydro-nephrosis exists or not, life may be prolonged by many days. *Spontaneous cure sometimes occurs.* Legueu states that out of fifty-six cases of calculous anuria, which neither followed nor were treated by operation, recovery took place in sixteen; *i.e.* in 28·5 per cent. In one the secretion recommenced on the third day; in ten between the fifth and tenth days; in three on the thirteenth, fourteenth, and fifteenth days respectively, and in two instances on even a still later day. Of the forty deaths, twenty-three occurred between the fifth and fifteenth days, one on the fourth day, and the rest on and after the sixteenth day.

Of forty-eight cases not operated upon which I collected, thirty-eight died and ten recovered; of forty-nine cases operated upon, twenty-four died and twenty-five recovered. Thus there is a percentage of recoveries in cases operated upon of fifty-one as against 20·8 in cases not operated upon. These figures speak loudly in favour of operation for calculous anuria.

Merklen says that, while it is uncertain up to what date we may hope for spontaneous recovery, the chances of recovery diminish with the prolongation of the anuria. According to Sir

William Roberts, the fatal termination is at hand when contraction of the pupils and convulsive tremors of the limbs occur. Recovery, he thinks, may be hoped for as long as these phenomena have not been observed.

Spontaneous recovery from an attack of anuria is announced by an abundant polyuria, or by the discharge of gravel, blood-clot, or calculi. The re-establishment of the secretion is often immediately preceded by the free action of the bowels, or by the escape *per rectum* of an abundant quantity of intestinal gas.

The polyuria which commences the spontaneous cure lasts many days, and consists in the discharge of immense quantities of urine at short intervals. This polyuria is often associated with albuminuria. The urine discharged after the expulsion of a calculus is generally albuminous. The albumen is slight in amount, but it continues as long as the polyuria.

When a first attack of anuria has been of short duration, and then ends spontaneously, recovery may be complete, as the calculus which caused it may have escaped from the ureter. When the anuria has been recurrent, or of long duration and complete, the recovery, if it occurs, is imperfect; and the individual, possessed as he is of only one active kidney, will have a precarious existence, perpetually threatened by another attack, from which, in great probability, he will not escape with the same good result. There should therefore be no delay in operating in cases of relapsing attacks of anuria, even when these attacks are incomplete and of short duration.

The pathological anatomy of calculous anuria may be summed up in the statement that the ureter or renal pelvis of one side has become recently occluded, whilst the kidney of the other side is either congenitally absent or functionally suppressed or structurally destroyed by calculus or some other form of renal disease. Rarely does simultaneous obstruction of both ureters by calculi occur, although this has been known to happen. In one published case (Amoden's), a large stone embedded in the trigonal area of the bladder simultaneously obliterated the vesical orifices of both ducts; and the same condition was found in a case which ended fatally in the Middlesex Hospital (*see* Figs. 125 and 126, pp. 148 and 149).

When the calculi occupy the renal pelvis they may either cause complete obliteration of it by their bulk, or may act as a ball valve over the upper end of the ureter.

Never, according to Merklen, has calculous occlusion of one ureter given rise to fatal anuria if the kidney and ureter of the opposite side are normal.

Legueu, from an analysis of thirty cases in which there were post-mortem examinations, found that on the side last obstructed there were calculi in the pelvis of the kidney in seven and obliteration of the ureter in twenty-three instances. On the other side there was congenital absence of the kidney in three cases, atrophy or other change caused by calculus in twenty, and obliteration of the ureter in six.

In one case, and in one only, there was nothing more than a slight epithelial proliferation of the tubules. Still, though this was insignificant in degree, it was nevertheless enough to alter the functional capacity of the organ.

Legueu found only two instances of fatal anuria in persons with one kidney sound. These are the cases of Bourgeois * and Nepveu, and in one of these the anuria was traumatic.

In twenty-eight of the cases I have collected in which the state of the two kidneys is given, the condition of the principal kidney was enlarged in eight, enlarged and congested in four, small in two, pyo-nephrotic in six, and hydro-nephrotic in eight. The condition of the opposite kidney was as follows: No trace existing in six cases; marked atrophy in eight, in two of which the ureter had become impervious; almost entirely disorganised by calculus in eleven; destroyed by a hydatid cyst in one; enlarged in two.

But though there is, as a rule, a pronounced and long-standing alteration in one kidney before the other and functionally active organ becomes obstructed, still in a proportion of instances the long-damaged organ had been doing a certain amount of excretion up to the moment of the onset of the anuria. This impaired function becomes quite suppressed by the inhibitory reflex influence due to the sudden occlusion of the good kidney.

In short, if we leave on one side the rare instances in which both ureters become simultaneously occluded, we see, as Legueu points out, that three factors are required to produce calculous anuria.

1. A long-standing change in one of the kidneys, causing a diminution if not suppression of its function; or else a congenital anomaly (absence or atrophy).

2. A recent or recently aggravated lesion of the principal kidney. This lesion is mechanical, and caused by a calculus.

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* Guyon and Tuffier, *Ann. des Mal. des Organes Gén.-urin.*, 1888.

3. A reflex inhibitory effect upon the disorganised kidney, leading to complete suppression of its imperfect functional power.

Whilst the surgeon in most cases can do nothing for the first of these defects, he can remove the cause of the second and thereby correct the third. Or if he cannot, by removing the obstruction, re-establish the flow of urine along the ureter, he can create an artificial opening—a urinary fistula—and thereby relieve the suppressed function of the principal kidney and very probably the reflex suppression of the other also.

Out of twenty-three cases of ureteral impaction, the calculus was found in the upper extremity in thirteen, and in the vesical extremity in six. In four cases the stone was situated at some intermediate point.

If to the thirteen cases of high ureteral impaction are added the seven cases in which the calculi occupied the infundibulum, we find twenty out of thirty cases in which the stone could be removed by an ordinary exploration of the kidney.

The dilatation which takes place behind a sudden obstruction is very moderate, so that the quantity of urine in the ureter and renal cavity is very small. The pelvis of the kidney contains only a little urine, which is frequently blood-stained. The kidney itself is generally hypertrophied and congested, and thereby enormously increased in volume; but, as a rule, it is not markedly hydro-nephrotic. Numerous cases prove that impaction of a calculus in the ureter is much more likely to be followed by an immediate arrest of the secretion of urine than by retention of urine and dilatation of the parts above the seat of obstruction, because the ureter and renal pelvis are not susceptible of sudden dilatation.

Ecchymoses on the surface and in the substance of the kidney and true infarcts are lesions which have been obtained by experimental ligation of the ureter, and have been found in some cases of obstruction at the time of operating, and in others at the post-mortem examination.

When the obstruction has been intermittent or imperfect and progressive, and not sudden and complete, hydro-nephrosis will be found.

The cases of hydro-nephrosis are, however, very exceptional, although slight dilatation of the calyces and numerous small sts in the cortex are common conditions.

Such are the changes which involve the principal kidney, and lead immediately to anuria.

The changes in the other kidney are of more or less ancient date. Simple atrophy without hydro-nephrosis is one of the most frequent consequences of old calculous obstruction of the ureter.

The sudden obstruction of one organ whether by ligature or disease, when the other is intact, culminates in *atrophy* without dilatation. In the same way the sudden obstruction of a single kidney causes almost immediate suppression, and not hydronephrosis.

Hydro-nephrosis with great thinning of the parenchyma is, however, sometimes found. In these cases the calculus which has been the starting point of the hydro-nephrosis may have long ago escaped, leaving behind a condition which results in a strictured or even an impermeable ureter.

Diagnosis.—The occurrence of former attacks of renal colic followed by the sudden onset of pain on one side and accompanied or immediately followed by anuria, points at once to obstruction of a calculous nature.

The diagnosis will be further strengthened if a swelling or distinct tenderness on pressure is present in the renal region or in the course of the ureter of the side recently become the seat of pain; or if the previous attacks of colic have been accompanied or followed by the passage of gravel. Too much stress must not, however, be laid upon the absence of this last symptom as disproving the renal origin of the attacks, for while its presence confirms the diagnosis, its absence is of little value and must not be taken, as it sometimes has been, to indicate that the attacks are biliary in nature.

But in some cases there is not a distinct history of previous attacks of renal colic, and yet one kidney may have become silently but entirely obstructed or destroyed by calculi. Occasionally the decision as to which side is affected is made easier owing to the knowledge of the condition of one kidney which has been obtained by a previous operation, and in a few cases all doubt has been set at rest by the fact that one kidney had been previously removed.* In Meyer's case there was no actual calculus found, but the ureter was blocked by the *debris* arising from a renal abscess.

In other cases there have been previous attacks of renal colic or pain, but the patient has forgotten on which side the pain was felt.

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* Lucas, *Lancet*, 1891, i., p. 144; Meyer, *Annals of Surgery*, April, 1892; also Bardenheuer and F. Lange.

If under these circumstances anuria sets in, it may be difficult or impossible to diagnose on which side the recent obstruction exists. The surgeon thus in doubt must seek information by the examination of the patient in the following manner:—

1. The ureter should be palpated, if possible, through the abdominal parietes. This is often an impossibility, owing to the stoutness of the patient. The ureter in which a calculus is impacted is likely to be inflamed and painful, as well as tender; even when a calculus has passed along the ureter it is likely to be followed by pain, lasting several days after its escape.

2. Rectal and vaginal examination should be made. In the male, digital examination *per rectum* has led to the discovery of a calculus impacted in the lower part of the ureter, as in Rawdon's and Ceci's cases; in the female, the same discovery has been made by vaginal examination by Emmet and by myself, and I have also detected the presence of a stone by vesical examination after dilating the female urethra.

3. Catheterisation of the ureters, though easy of application in the female, does not afford satisfactory assistance in these cases, whether the catheter is introduced across the bladder through the dilated ureter, or through the opening made by vaginal cystotomy as practised by Bozemann and Emmet, or by the aid of supra-pubic cystotomy. The ureteral cystoscope in cases of anuria is quite unnecessary and, in my opinion, out of place, as it can give no information which is not more fully ascertained by rectal or vaginal examination and by a sound in the bladder. Valuable time will be lost by such explorations of the ureter, and it will be far better at once to resort to exploration of the kidney.

If there be a calculus in the terminal part of the ureter, it will almost certainly, if of any size, be detected by either rectal or vaginal examination, and can be extracted by one of the operations to be mentioned later on. But if by these modes of examination nothing is detected in the inferior extremity of the ureter, we ought without delay to explore one or both of the kidneys through the loin, and to select first the side on which recent pain, or tenderness or swelling, or a hard contracted condition of the abdominal walls, exists or has recently existed. Through such an incision the kidney and adjacent part of the ureter can be seen and felt, and the rest of the ureter catheterised; and if a stone be found it will be possible to remove it, while if no stone be found, then by establishing a renal fistula relief will be given to the congested state of the kidney, and a condition will thereby be brought about favourable to the resumption of the secretion of urine.

Calculous anuria and uræmia have to be diagnosed from non-obstructive forms of anuria, and from other forms of obstructive disease.

The anuria occurring with cancer of the uterus and the anuria caused by rare varieties of tumour of the bladder or ureters; by uterine myomata; and, in exceptional cases, by the gravid retroflexed uterus, is in some respects like calculous anuria; but differs very markedly in others, and especially in the development of hydro-nephrosis so common in cancer and these other cases, but so uncommon in anuria from calculus.

From uterine cancer.—Cancer of the uterus is the most frequent cause after calculus of obstructive anuria. Indeed it is probably more frequent even than calculus as a cause of anuria. I have seen many cases of anuria from uterine cancer in the cancer wards of the Middlesex Hospital; but I do not remember ever to have seen uræmia from this cause arise before any of the ordinary symptoms of carcinoma of the uterus have declared themselves. Such cases, however, have been recorded and have given rise to difficulty in diagnosis, as the suddenness of the attack has suggested calculous anuria. Avan reported a fatal case of uræmia attended by eclampsia and prolonged coma in a woman who had never complained of any of the symptoms of uterine cancer, and who was suddenly seized with eclampsia in the street and died. Cancer of the uterus was found on post-mortem examination to have caused double hydro-nephrosis by pressure on the ureters.

Complete and prolonged suppression of urine at an early period of the cancer, or in uterine cancer which has been latent up to the onset of the anuria, is also recorded. Merklen quotes cases of total suppression for seventeen and twenty-one days due to uterine carcinoma which had not previously caused any of the classical symptoms of the disease. Roberts also cites a case of the same kind, in which anuria lasted fifteen days and presented the clinical symptoms and followed the course of calculous anuria. Such cases are very prone to be mistaken for anuria from impacted calculus.

Primary cancer of the bladder may obstruct the ureters, like uterine cancer when it has invaded the trigone. Roberts records a case in which the symptoms were those of calculous anuria; but at the post-mortem examination scirrhous carcinoma at the base of the bladder was found, involving the prostate gland, and both ureters passed for the length of an inch through the growth. Double hydro-nephrosis—old on one side, recent on the other—was the result.

Suppression has been known to occur suddenly and to be followed by uræmia, vomiting, and fever, as the result of secondary carcinoma in the renal pelves and ureters. Voluminous tumours of the uterus or its appendages may obliterate the ureters and give rise to suppression.

Many cases after operations for myoma of the uterus succumb to uræmia with dilatation of the ureters and renal pelves.

The diagnosis between calculous anuria and cases of anuria from uterine cancer and the other causes of ureteral obstruction will be assisted by digital examination of the vagina and rectum, and by palpation of the abdomen.

From traumatic anuria.—Calculous anuria will be diagnosed from traumatic anuria, in which the vessels of both kidneys are thrombosed, by the symptoms following an injury.

After extensive thrombosis of the vessels—arteries or veins—of both kidneys, urine in great quantity is said to have been passed, as in the case recorded by Moxon in the fourteenth volume of the *Guy's Hospital Reports* (pp. 99 *et seq.*).

Anuria following operations upon the lower parts of the urinary tract, as for instance the passage of a catheter, will generally be differentiated without difficulty by the direct relations which exist between the operation and the onset of symptoms, by the presence of general malaise at the onset and of the rigors, high temperature, and intense prostration which accompany urinary fever; and also by the absence of anything in the previous history of the patient which points to the presence of a calculus. Occasionally, however, difficulties may arise in cases where symptoms simulating those of a calculus have existed previous to the operation, but here the duration of the anuria will generally make clear the cause upon which it depends.

It must, however, be remembered that a reflex suppression of urine can arise from irritation of the lower urinary tracts other than that due to operation. Broca relates a case of this kind in which a tumour of the bladder and prostate which obstructed the ureter on one side was finally followed by cessation of function of the kidney of the other side, although there was no obstruction.

Nephrotomy was performed on the kidney whose ureter was obstructed, and a fistula established through which the pent-up urine could escape. With this relief the opposite kidney again resumed its functions, and the patient made a good recovery from this attack, but died later from other effects of the tumour.

Uræmia arising in the course of *Bright's disease* is usually characterised by a much greater disturbance of the nervous system than that arising from obstruction due to calculus. For while, as has already been pointed out, in the obstructive cases the patient remains calm, with the mental faculties clear or only a little impaired, till near the end; in the non-obstructive cases coma and convulsions preceded by headache and giddiness are frequently among the prominent symptoms. The uræmic symptoms of chronic Bright's disease, moreover, as a rule come on gradually, and the history of the case, together with the characteristic symptoms of the disease, such as high arterial tension, cardiac hypertrophy, retinal and other changes, will lead to a correct diagnosis. Swelling of the parotids may occasionally occur in uræmia, but it is a very rare complication.*

Amyloid degeneration is attended commonly by polyuria, albuminuria, and paraglobinuria; œdema is frequent, diarrhœa common, and vomiting and uræmia rare. The course is one of slow progress with remissions. The duration of the symptoms is considerable. When uræmia occurs in amyloid degeneration, as it does in some cases towards the end, the symptoms which I have observed are great restlessness and sleeplessness, delirium approaching the noisy form, contracted pupils, marked muscular twitchings, diarrhœa, diminishing quantity of urine, with loathing of food and loss of control of the sphincters. Just preceding death the patient becomes quieter and coma supervenes.

The recognition of anuria due to hysteria usually presents no serious difficulty on account of the other hysterical manifestations which almost invariably precede and accompany this condition.

Anuria due to drugs such as cantharides, turpentine, and mercury comes on more gradually than that due to calculus, and the history of such cases usually clears up all doubts as to their nature.

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* Richardière, *Journ. de Méd.*, Mars 10, 1897; *Brit. Med. Journ.* Epitome, Aug. 14, 1897.

From polycystic disease.—A case of anuria from double polycystic disease, in which the symptoms and history were those of calculous obstruction, was recently under my care. The patient, a rather stout but well-made, muscular man, aged fifty, first had pain in his right loin in 1884. Subsequently he frequently passed gravel, and in 1894 after attacks of pain in the right kidney he discharged a small stone. After this he became very indifferent in health, suffering pain in the right loin. On March 16th, 1898, he had another attack of pain like the former ones, but in the left side as well as the right, and passed very little urine afterwards. Both his kidneys were cut down upon, first the left, then two days later the right. Both kidneys were found in the same state. Several cysts were opened in each, and the lessened tension resulting therefrom gave him some relief. He died on March 24th, the ninth day of the attack, after five days of complete suppression. Muscular twitchings, meteorism, sleeplessness, restlessness, a small rapid pulse, pallor of face, blueness and coldness of extremities, and at last subnormal temperature and dyspnœa were the chief symptoms. A post-mortem examination showed cystic degeneration of both kidneys and of the liver also. There was no stone or other gross obstruction present throughout the urinary organs.

Treatment.—The treatment of anuria up to seventeen or eighteen years ago was entirely medical. The line of treatment usually adopted was purgative, diuretic, diaphoretic, and anti-spasmodic drugs, baths, forced exercise, and massage. Drugs, such as digitalis and pilocarpine, for example, which induce the elimination of an increased quantity of water from the system, remove only a small quantity of the products of metabolism, and thus leave the blood proportionately more highly charged with these poisonous substances. For this reason such supposed remedies ought to be ordered with extreme precaution in obstructive anuria.

The surgical treatment of calculous anuria is a question of the day, and one of the greatest importance. Formerly no one dared to do more than suggest operation, though Rayer, and Gigon in 1856, had strongly recommended it. It is only since nephrolithotomy was practised that operations have been performed for anuria, and there are already several cases which show the advantage of well-timed surgical intervention. At the present day the necessity of operating ought to be recognised, nor ought opinions to differ as to the period of intervention or as to the kind of operation to be performed. By an operation the calculus should be removed, or if this is not possible an artificial outlet should be established in the loin.

Nephrotomy should be performed in the gravest cases to prevent death from uræmia; in the slighter and intermittent cases to extract a stone which may at any time produce complete persistent anuria.

Nephrotomy for obstructive anuria is only a recent application of a long-recognised principle of practice in other fields of surgery. Why in the case of an obstacle in the ureter should we hesitate to relieve the obstructed kidney? Is it not all the more imperative upon us to do so when the obstructed kidney is the only one which is functionally active?

When the obstructing calculus is too low down in the ureter to be removed through a lumbar wound, the parietal incision should be prolonged towards Poupart's ligament, the peritoneum should be detached and pushed inwards towards the median line, and the stone cut upon through the ureteral wall and extracted.

When the calculus is in the lower portion of the ureter, or within or close to the vesical orifice, the advisability of adopting one of the special methods for reaching the ureter in these parts will have to be considered; but in many cases the state of the patient will make it necessary to postpone any such operation for a time at least. Should the obstruction not be removed at the primary operation a lumbar renal fistula should be established; ureterotomy may be subsequently successful, or the stone may be naturally expelled and thus the normal channel will be opened up, and the fistula allowed to close.

Opinions have hitherto differed as to the precise time when the surgeon should interfere. To be successful it is certain that the operation should be done early and before the uræmic stage is reached. But since this stage is generally delayed till after the sixth day, some authors have advocated the fifth or sixth day as the period of surgical operation.

In a case recorded by Demon* the intervention was made on the eleventh day, and in one related by Chevalier† on the fourteenth, with complete success; but, on the other hand, operations on the third day have been unsuccessful in restoring the secretory function. Moreover eclampsia necessitating immediate operation may occur as early as the third or fourth day of the anuria, as in a case reported by Vailhen.* Sudden death may occur early in an anuric person who seems to be in fair general health.

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* *Annales des Maladies des Organes Génito-urinaires*, 1894, p. 97.

† Quoted by Vailhen in Thèse "L'Anurie Calculeuse," 1896, p. 19.

Willy Meyer of New York, in a suggestive paper on a very interesting case, points out the advisability of performing nephrotomy on the remaining kidney in the cases, happily rare, in which suppression of urine sets in immediately after nephrectomy and continues—threatening the early termination of the life of the patient. Quoting F. Lange's case in support of his argument, he thinks that total suppression after nephrectomy, if the remaining kidney had previous to the operation been known to be working well, is often due to mechanical obstruction in the ureter of the remaining kidney either by a calculus or a plug of muco-pus or of blood, and that if nothing is done death must ensue; whereas if an obstruction is found and removed there is hope of recovery, and if the obstruction is not capable of being removed, relief, at any rate, will be given to the renal retention.

An operation ought in my opinion to be performed as soon as the anuria is established and the diagnosis is satisfactorily made. Nephrotomy is serious only on account of the condition for which it is performed—viz. (1) the urinary suppression produced by the obstruction, (2) the poisoned condition of the blood produced by the suppression, and (3) the structural changes in the kidney consequent upon the obstruction.

The operation should be performed on the side *last* affected, when the indication on this point is clear. It is not the kidney which has longest suffered or which has yielded most calculi which ought to be incised. The contrary ought to be the rule, because the more the kidney is affected the more extreme its degeneration, the less the secretion which it will yield, and consequently the less the benefit which will accrue from nephrotomy on that organ.

In the absence of exact history drawn from the patient himself it is necessary to try and ascertain by careful examination of the abdomen which kidney to explore. When there is no enlargement of the kidney and no pain or tenderness there may yet be a considerable degree of hardening from contraction of the abdominal muscles over the part of the kidney which is last involved. Radiography may possibly give some assistance, but the cystoscope and the ureteral catheter are useless where there is complete anuria.

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* Thèse "L'Anurie Calculeuse," 1896.

In most cases it will be best to explore the kidney first; the exceptions being those cases in which the stone can be felt *per rectum* or *per vaginam*, or in which other evidence clearly points to the side and precise spot in the ureter at which it is impacted. Under these circumstances ureterotomy should be performed. The localisation of a stone, as to whether it be in the kidney or ureter, is very uncertain: most frequently when impacted in the ureter the symptoms it causes are referred to the corresponding kidney; but occasionally the reverse obtains, and a stone in the renal pelvis gives rise to fixed abiding pain and acute tenderness at one particular spot in the course of the ureter.

The nature of the operation performed in the forty-nine cases which I have collected was as follows:—

1. *The operation was stated to have been nephrotomy*, or (in a few cases) merely exploration of kidney in thirty-four cases. In one of them the operation was performed by the thermo-cautery.

2. *An incision of the renal pelvis, i.e.* pyelotomy, was the operation in five cases. One was done by the thermo-cautery.

3. *An incision of the ureter, i.e.* ureterotomy, was performed in seven cases. One was performed through the rectum. In one case, not included in the forty-nine mentioned above, an attempt was made to remove an obstruction from the lower end of the ureter by means of the finger in the bladder. In two cases not included in the list of forty-nine operations I have removed calculi through the sacral route.

CHAPTER XXVII.

OPERATIONS ON THE KIDNEY, AND THE METHODS OF PERFORMING THEM.

Besides the simple puncture with the aspirator, or trocar and cannula, there are six recognised operations now practised upon the kidney for diseases or injuries.

1. **Nephrolithotomy** (*νεφρός* = kidney; *λίθος* = stone; *τέμνω* = I cut), an incision into the secreting substance or pelvis of the kidney, with the express purpose of removing a calculus therefrom, at a date in the progress of the disease prior to the disorganisation of the renal substance or to the conversion of the renal pelvis into a large abscess cavity.

2. **Nephrotomy** (*νεφρός* = kidney; *τέμνω* = I cut), an incision into the renal substance or renal pelvis either for an exploratory purpose, for the relief of pain from tension, for the removal of a calculus from the dilated and sacculated or suppurating kidney, for the evacuation of urine or pus in conditions of nephrectasis, for opening an abscess or cyst, or to provide an exit for urine in cases of complete or partial anuria from obstructive causes.

Nephrotomy is sometimes performed upon a structurally normal kidney, as, for example, when it is resorted to in certain cases of nephralgia due to tension, for the relief of renal retention in obstructive anuria, or with the object of exploring for calculus. In the greater number of cases, however, the kidney itself is distended, sacculated, suppurating, or otherwise organically diseased.

3. **Nephrotresis** (*νεφρός* = kidney; *τρῆσις* = making a hole, from *τετραίνω, τρήσω* = to perforate), an incision into either the renal parenchyma or renal pelvis followed by the suturing of the cut edges of the kidney to the cut edges of the parietal wound, with the object of establishing a permanent aperture through which the urine secreted by that kidney may be discharged from the body.

4. **Nephrorraphy** (*νεφρός* = kidney; *ῥαφή* = a sewing, from *ῥάπτω, ἔρραφον* = I sew), or as it is now, and more correctly, called

Nephropexy (*νεφρός* = a kidney; *πῆξις* = a fixing, from *πήγνυμι, πήξω* = I fix) consists in cutting down upon and exposing the kidney, with the object of fixing a floating or movable kidney in its normal or nearly normal position.

5. **Total nephrectomy** (*νεφρός* = kidney; *ἐκτέμνω* = I cut out), is the complete removal of a kidney either for disease or injury or fistula.

6. **Partial nephrectomy** is the removal of one or more wedges or segments, or of a still larger portion of a kidney, when the rest of the organ is healthy or of good functional power.

Situated as and where they normally are, the kidneys can be reached for surgical purposes either from behind, *i.e.* through the loin, or from in front, *i.e.* across the abdominal cavity. As a matter of fact, each of the above six classes of operations has been performed by both routes. Thus the operations on the kidney have come to be divided into two groups, namely, the lumbar or extra-peritoneal, and the abdominal or trans-peritoneal. A few years ago the opinions of surgeons were divided as to the advantages and disadvantages of these two ways of operating, and their practice varied accordingly. Even at the present time it can hardly be said that there is perfect unanimity; but it may certainly be stated that the trans-peritoneal method is now almost exclusively reserved for total nephrectomy in certain cases of tumours, and in cases of rupture of the kidney when the surgeon before operating is uncertain as to the exact nature and extent of the abdominal injury; and that for all the other operations practised upon the kidney the surgeons who have had the most extensive and varied experience in them are agreed upon the great superiority and greater safety of the lumbar method.

Prefatory Remarks on Operating on the Kidney.

Important anatomical points.—The anatomical relations, the abnormalities and varieties of form, and the misplacements of the kidney, having been fully described in the early chapters of this work, will not be further referred to here, except to bring back to memory the following salient points of surgical anatomy:—

1. The normal position of the kidneys is on a level with the twelfth dorsal, upper two lumbar, and part of the third lumbar vertebræ.

2. The outer border of the lower part of the kidney projects about a finger's breadth beyond the outer border of the mass

of the erector spinæ muscles, and is most accessible at this spot just below the last rib.

3. The kidneys rest about equally upon the diaphragm and the anterior layer of the transversalis aponeurosis which separates it from the quadratus lumborum muscle. Along their inner border they rest also upon the psoas.

4. The hilum is about on a level with the lower border of the spinous process of the first lumbar vertebra.

5. Nearly the whole of the posterior surface of the kidney is covered by the eleventh rib, the last intercostal space, the twelfth rib, and the lumbo-costal ligament of Henle, which extends between the tips of the transverse process of the first and second lumbar vertebræ to the twelfth and the eleventh ribs, and which is in fact a thickened portion of the movable layer of the transversalis aponeurosis (*see* Figs. 1 and 2, Vol. I., pp. 2 and 5).

6. The length of the twelfth rib varies much in different persons, being in some of considerable length, taking a very oblique direction and then covering a considerable part of the kidney; in others it is short and horizontal and covers only a very small area of the renal surface. Holl of Vienna found the twelfth rib wanting in three subjects out of sixty, *i.e.* in one person in twenty, and that the last rib in a considerable percentage does not reach beyond the sacro-lumbalis. Récamier's observations on this point show that in seventy-seven out of 114 cases the length of the twelfth rib was from half to three-quarters of the length of the eleventh rib; and in seven out of thirty-seven it was only one-third or less.

7. The pleural *cul-de-sac* descends below the twelfth rib along the side of the spinal column, but beyond the outer edge of the erector spinæ this *cul-de-sac* is protected by the posterior two-thirds of the twelfth rib when that rib is long; but as the *cul-de-sac* may descend below the eleventh rib its lowest part may not be protected by rib when the twelfth is very short. When the twelfth rib is long (and it is so in two out of every three cases), the anterior third of the bone is below the reflection of the pleural sac.

8. It is important, in connection with perinephric suppuration and extravasation, to know that the fibres of the diaphragm which are in apposition with the posterior surface of the kidney form an exceedingly thin layer, and oppose a very feeble resistance to the spread of fluid towards the pleural *cul-*

de-sac. Further, immediately outside the bundle of fibres which are inserted into the fibrous arch over the psoas muscle at the level of the transverse process of the first lumbar vertebra, there is a triangular interval between the diaphragmatic fibres where the kidney is in direct contact with the inferior part of the pleural *cul-de-sac.* This diaphragmatic "hiatus" explains how an inflammatory lesion of the kidney can readily spread to the pleura, and how purulent collections around the kidney can open into the pleural cavity without actually perforating the diaphragm (*see* Fig. 6, Vol. I., p. 11).

9. Where there is a condition of ptosis of the abdominal viscera, the liver on the right side or the spleen on the left is very likely to present itself, instead of the kidney, in the depth of the wound after the division of the transversalis aponeurosis.

10. The colon, which lies over the front of the lower third of the right kidney and over nearly the lower half of the left, extends farther outwards than the kidney, and is not unlikely to bulge into the wound when the transversalis aponeurosis is cut.

11. The length of the space between the vena cava and the inner border of the right kidney is about one inch and three quarters, and the distance between the aorta and the inner border of the left kidney is two inches.

The preparation of the patient.—For each of the above operations the patient should be prepared in practically the same manner.

(*a*) The large bowel should be well emptied by means of an aperient given the night but one or the night before the operation, and an enema on the morning of the operation about three or three and a half hours before the operation.

(*b*) The skin of the loin, of the lower part of the thorax, and of the buttock on the side to be operated upon, and of the umbilicus and the front of the abdomen should be carefully cleansed on the day prior to the operation. The plan I employ is to have the skin first washed with hot soap and water and dried, then with turpentine, and again with hot soap and water; after this the surface is well sponged with a solution of one in twenty of carbolic acid, and lastly the surface is covered by a compress of gamgee tissue wrung out of a solution of one in forty of carbolic acid, and retained in place for twelve to eighteen hours.

(*c*) An investigation should have been previously made as to the average daily amount of urine secreted; this must be done by measuring the quantity passed in twenty-four hours for three successive days. The general characters of the urine, the amount of urea excreted, and the presence of albumen or of any abnormal elements in the sediment, should also have been ascertained.

(*d*) The urinary bladder should be emptied immediately before the operation. If there is any intention of making an inspection or digital examination of the bladder when the patient is anæsthetised, the external urethral orifice, and the vagina and vulva, or the glans penis, as the sex may be, should be well cleansed beforehand.

(*e*) When under the anæsthetic, and after the compress has been removed, the skin in the area of operation should be again washed first with ether and cotton-wool, and then with a 5 per cent. solution of carbolic acid.

(*f*) Precaution should be taken against undue exposure of the patient to cold during the operation. With this object, after the patient is placed in position, I surround the upper part of the trunk with a thick, well-warmed bath-towel, folded in two longways, and pinned firmly but not tightly around the chest and the arm and forearm which are uppermost. The lower edge of this towel must be sufficiently above the area of operation. Another bath-towel is similarly pinned around the hips; and the patient's back in the interval between these towels is covered by a well-warmed, folded small towel, the ends of which are tucked under the edges of the towels surrounding the chest and hips.

The bath-towels serve the further purpose of keeping off the dampness of the outspread wet carbolised towels.

The instruments, sponges, and loin pillow.—*Instruments.*—All instruments should be sterilised immediately before being used. Besides those required for any ordinary operation, the following special instruments are necessary:—

A pair of broad and a pair of narrow deep retractors, a medium-sized trocar and cannula, long-bladed narrow bistouries (one sharp- and one blunt-pointed), a narrow scoop, and one or more renal calculus forceps (straight and curved), a pair of very small-bladed sharp-pointed scissors or a sharp-pointed fine tenotomy knife for making an aperture into the renal pelvis; Spencer Wells's pedicle forceps, curved and straight; long sponge-holding forceps, long curved pedicle needles, sharp and blunt; flexible bougies of No. 1-3 sizes and fifteen inches in length, for passing down the ureter to the bladder; a slender, flexible Sayer's probe with a cap of porcelain is also sometimes useful as a test whether an obstruction in the ureter is due to the rough surface of a calculus; very small Hagedorn's or round curved needles for closing an incision in the renal pelvis or in the ureter; large curved needles for suturing the parietal incision.

As there is often a probability that the bladder may require to be examined, bladder sounds and the cystoscope or Kelly's tubes should be at hand.

The sponges.—The sponges will of course have been prepared and sterilised. There should be at hand flat as well as round sponges. They should be counted, and the number noted down. This requires special mention, because it is apt to be forgotten that one or more may have to be packed into a loin wound, above, below, behind, or in front of the kidney, and if there is no check on the number in use a sponge may easily be left in the wound. Sponges, not swabs, should be used; swabs are used for cleaning away pus and purulent urine after the opening of an abscess or a pyo-nephrosis, with the object of retaining the asepticity of the sponges. Swabs are dangerous in kidney and abdominal operations, because of the probability of their being uncounted, and therefore of one or more being left in the body. I have heard of this happening in two or three cases of renal operations. In one case the presence of a foreign substance was suspected from the appearance of the wound, which on the second or third day after the operation was opened up, and two swabs were removed; and in another case the swabs were discovered at the post-mortem examination.

A loin pillow is always useful, and in some cases quite a necessary adjunct. It is easily made by folding longways an ordinary feather pillow and surrounding it with mackintosh and a bath or ordinary towel, which is pinned over all. It is placed under the loin of the sound side, and is of use in widening the space between the crest of the ilium and the twelfth rib on the side of operation. It can also be made to steady a very movable kidney and prevent it from falling over the front of the spine when the patient is placed upon her side.

The position of the patient for the lumbar operations.—This should be upon the sound side, with the knees well flexed and the thighs bent to an obtuse angle on the trunk, the upper thigh being slightly more flexed than the lower. The undermost arm should be partly beneath the thorax, and the shoulders should be somewhat curved towards the knees. The loin pillow is placed longways across and beneath the opposite loin. By means of the pillow and this position the ilio-costal space is widened out to its fullest extent—a matter of the greatest importance in operations on the kidney (as distinct from those on the ureter) during the manipulations for isolating and delivering the kidney into the loin, more especially when the ilio-costal interval is a small one.

The operating table should be so placed that as much light as possible falls upon the loin and into the wound. It is generally better, especially in the case of women with wide hips, to have the head, not the feet, of the patient obliquely towards the light; with the body on the side and inclined, as it should be, towards the prone position, the shoulders obstruct the light much less than do the hips.

It is well to have two assistants, besides a nurse or an assistant who attends exclusively to the instruments, the sutures, and the ligatures. One assistant should stand by his side, the other opposite the surgeon, ready to retract the edges of the wound, or to press the kidney towards the loin during the process of isolating the kidney from its investing tissues.

The after-treatment.—This may be described once for all, because after every operation involving the kidney the same treatment is requisite. The patient should be placed in bed, upon her back, with a small soft pillow under the scapula, and another under the hip of the affected side. Thus there will be a slight rotation towards the sound side, and *there will be no pressure on the wound.*

In nearly all cases it is, at least in my opinion, essential to employ drainage for the large cellular and fatty tissue space surrounding the kidney. The exception is in nephropexy in a very thin person where there has been only slight bleeding and but very little disturbance of the parts involved during the operation. The raw surfaces, and the united edges of the wound, should be sprinkled with a little iodoform or aristol—these substances check serous exudation, and tend to keep the wound dry, and thereby aseptic. The wound is covered widely with two or three thicknesses of dry gamgee tissue, over which are several layers of double cyanide or mercuric gauze, and over all a wide binder.

This binder is drawn very tightly around tne abdomen and hips, but slackly around the lower part of the thorax. After nephropexy, and also after lumbar nephrectomy, it is well to place a large square pad of gamgee tissue or cotton-wool on the front of the abdomen of the side operated upon before fastening on the binder. This in the case of nephropexy steadies the kidney which has just been fixed, and in nephrectomy aids in pressing together the surfaces of the cavity from which the kidney has been removed.

Feeding by the bowel should be continued until the effects of the anæsthetic have passed off and the stomach can retain food. A good nutrient enema consists of three ounces of beef-tea, half an egg and from ʒij to ℥ss of brandy, half of which should be given either directly or within three or four hours after the operation and repeated every four, six, or eight hours, according to the condition of the patient. If there is much chloroform sickness, bromide of potassium (xv. grs.) in the first or second enema is often effective in checking it. As the stomach regains its capacity for taking nourishment the rectal feeding should be gradually discontinued. From the first, hot water or hot black coffee should be allowed by the mouth in quantities of an ounce or two ounces at a time, and at frequent intervals—even though there is a feeling of sickness or actual vomiting. To forbid the taking of fluid by the mouth is to cause unnecessary distress. Hot water satisfies a mental and physical craving, gives a sense of relief by moistening the mouth, and whatever proportion of it is retained helps to stimulate the kidneys to secrete. Hot black coffee is useful in the same way, and with many patients allays sickness as well as thirst. No opium or morphia should be prescribed until the function of the kidneys or kidney is found to be satisfactory.

As retention as well as partial suppression of urine is apt to follow renal operations, the catheter should be introduced twelve or fourteen hours after the operation if no urine has been or can be voided naturally. The catheter may be required every eight or ten or twelve hours for two, three, or more days after an operation without there being anything amiss with the bladder or urethra. Even in cases in which urine is passed naturally, if there is any vesical irritation or the amount passed is below what might reasonably be expected, the catheter should be introduced on one or two occasions immediately after micturition to ascertain if the bladder is empty. If all the urine is not discharged the catheter should be used once or perhaps twice in the twenty-four hours, so long as the partial retention persists, otherwise much vesical disturbance is kept up, and probably an attack of cystitis will ensue.

The bowels should be made to act on the fourth or fifth day by giving an enema, consisting of four to eight ounces of pure glycerine in a pint or pint and a quarter of warm soap and water.

The first dressing of the wound is required as soon as any discharge appears beyond the edges of the dressings, or the dressing becomes uncomfortable, or the temperature rises to about 100° F. If none of these events occur it will be soon enough to change the dressings on the third or fourth day. The drainage tube should be removed altogether on the third or fourth day, unless there is a continuing discharge going on and a disposition of the drain-track to close immediately. Under the circumstances just stated the drain-tube should be retained, and shortened by degrees.

In the majority of cases of simple nephrotomy for exploratory purposes, or nephrorraphy, and in very many cases of nephrolithotomy, there is practically no discharge at all after the first twenty-four hours, and the dressing will require changing very seldom. After nephrotresis there will be a constant discharge going on, needing a renewal of the dressings two or three times a day, possibly even oftener. After some nephrectomies for pyonephrosis and abscesses, especially when the perinephric tissues are much altered by inflammation, suppuration of the wound, and healing by a slow granulating process must be looked for, and a dressing may be required daily or twice daily. In some of these cases, especially in stout persons with flabby tissues, sloughs of the cellulo-fatty tissue will be cast off, and the process will be accompanied by purulent discharge having an offensive odour of a very clinging character ; in these cases stitch abscesses are common and cause a good deal of discomfort and prolonged suppuration.

The time required for the healing of the wounds after many operations of nephrolithotomy, simple nephrotomy, nephrectomy and partial nephrectomy is often not more than from eight to ten or twelve days. I have often had patients, after simple nephrolithotomy and nephrectomy, out of bed within the fortnight. In nephrorraphy the wound is as a rule well in eight or ten days, or at most a fortnight, but these patients must continue on their backs for a period of at least from four to five weeks after the operation.

When the wound suppurates, as it is apt to do after nephrotomy and nephrectomy for pyo-nephrosis, three or four or five weeks or even more may pass before healing is quite complete.

For many weeks after recovery the patient will do well to support the scar and the abdomen by means of a flannel binder, or a well-adjusted belt.

If symptoms of suppression of urine follow an operation on the kidney, more especially if there has been much loss of blood, saline injections into the bowel if they can be retained, or into a vein if the bowel resents their presence, have proved useful in some cases. A quart of normal saline fluid was successfully injected in a vein of the arm in a case of Dr. McBurney's.

Pilocarpine subcutaneously injected has also been of use, and in one or two cases I have found immediate re-secretion follow the use of one-eighth to one-sixth of a grain of morphia given subcutaneously; but morphia must be employed with extreme caution.

PUNCTURING THE KIDNEY

with a trocar or the aspirator has been performed for the relief or cure of hydro- and pyo-nephrosis, large isolated serous or blood cysts of the substance of the kidney, and for hydatid cysts. When from their degree of distension such swellings are causing serious consequences by pressure, or there is risk of the cyst wall rupturing, the contents ought to be evacuated in this way, if the patient is either in an unfit condition to undergo nephrotomy, or obstinately refuses to "submit to the knife."

As a means of diagnosis of renal calculus puncture of the kidney was used in the earlier days of renal surgery. It was always an uncertain and unsurgical measure, and might be adequately and appropriately described as "a plunge in the dark." Employed for this purpose, I should hope it has disappeared from surgical practice for ever,

The point selected for puncturing will depend on circumstances. If there be any spot over the swelling which is thin, soft, prominent, or fluctuating, the trocar should be there inserted. A point which is not seldom indicated is midway between the umbilicus and the anterior superior spine of the ilium; or half an inch below, and an inch and a half to the side of the navel.

When no particular spot is suggested by discoloration or prominence, no better place can be selected on the left side than an inch in front of the last intercostal space; but if the tumour be of the right side this is too high, as the liver would probably be traversed. If there is no indication for operating elsewhere, the best spot to select when the kidney is of the right side is half-way between the last rib and the crest of the ilium, between 2 and 2½ inches behind the anterior superior spine of the ilium.*

In performing the operation the aspirating trocar should be inserted without any previous incision of the skin; if a larger trocar be used, an incision through the integument and muscles is sometimes made before introducing the instrument.

The dangers of the operation are not slight. If the puncture be made too far forward, and through non-adherent peritoneum, some of the contents of the cyst might be extravasated into the peritoneal cavity on withdrawing the cannula, an accident which has proved fatal in more than one case. There is also the danger of wounding the intestine, which, as a rule, is in front of and adherent to the tumour; and if the trocar be long and be thrust too far inwards, it might penetrate some important blood-vessel, and cause dangerous if not fatal hæmorrhage. The penetration of the thin edge of the liver with an aspirating needle, though to be avoided, is not an accident likely to be followed by any ill consequence. The instrument should not be introduced too near the ribs, for fear of wounding the pleura.

Puncturing the kidney either before or after a lumbar incision cannot be recommended.

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* *See* paper by the author in the *Roy. Med.-Chir. Soc. Trans.*, vol. lix., pp. 242, 243 (1876).

CHAPTER XXVIII.

OPERATIONS ON THE KIDNEY, AND THE METHODS OF PERFORMING THEM *(Continued)* *

Nephrolithotomy.

This operation was first performed by myself in 1880. It has for some years past been firmly established as the proper treatment for stone in the kidney when the stone cannot pass into the bladder naturally, and before it has caused disorganisation of the renal parenchyma or distension of the renal pelvis and calyces. It has become one of the most successful operations in surgery, the mortality attending it in my practice not being higher than that of litholapaxy in the best hands.

Indications for the operation.—It should be performed unhesitatingly in all cases in which symptoms of renal calculus continue for some months uninfluenced by medicinal treatment, and are sufficiently severe to interfere with the comfort and ordinary pursuits of the patient. If for several months a person has been subject to more or less constant pain in one loin, and along the ureter, and perhaps also in the testicle of the same side; if there have been recurring attacks of renal colic; if with these symptoms there is occasional hæmaturia or the urine is constantly charged with a little pus or albumen, or a few blood cells are always or generally found under the microscope in the centrifugalised sediment; and if these deposits are increased by exercise and diminished by rest, we have the conditions not only justifying but demanding an exploration. If, further, a small calculus or a little calculous matter has been passed *per urethram*, the presence of a stone is made still more probable.

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* For the convenience of the reader, and with the object of making the account of Renal Calculus as complete as he could, the author has given some of the steps of certain of the operations on the kidney and ureter under the heading of "The Technique of the Operation for Exploring the Kidney and Ureter for Calculus" (p. 131). A certain amount of repetition, therefore, is necessary in the several chapters giving a systematic description of the operations on the kidney and on the ureter.

LUMBAR NEPHROLITHOTOMY.

The position of the patient.—The position of the patient has been described on pp. 177, 178. When the patient has been properly arranged in position and the skin has been re-washed, it is necessary, before commencing the incision, to make out the tips of the eleventh and twelfth ribs. If the twelfth rib is very short its extremity may be under cover of the sacro-lumbalis. If the twelfth rib is altogether absent the incision should not extend to within less than an inch from the eleventh rib, and care must be taken not to wound the pleura.

The line of incision.—An incision is made 4½ inches in length parallel with and three-quarters of an inch below the last rib. *The structures divided* are the skin, superficial fascia and fat, the outer border of the latissimus dorsi, and the posterior border of the obliquus externus abdominalis. Then the obliquus internus and, behind the incision, the fascia lumborum are exposed and divided to the full extent of the wound.

The last dorsal nerve and the subcostal artery and accompanying vein run along the lower border of the last rib, and usually escape being divided; but not unfrequently they pierce the lumbar fascia and take a lower course, and then they may cross the line of incision. If so, they are best divided, the artery being ligatured, and an inch or more of the nerve excised. If the last dorsal nerve, after keeping along the lower edge of the last rib, pierces the muscular fibres of the transversalis instead of the fascia lumborum, it will escape; but the lateral cutaneous branch of the last dorsal nerve, which pierces the external and internal oblique muscles and takes a downward course over the crest of the ilium, is necessarily divided. The trunk of the ilio-hypogastric nerve is usually below the line of incision, and is not seen; its hypogastric branch is lying parallel to the incision in front of the iliac spine and below it, and is not divided unless the incision is carried as far forward as the external abdominal ring, where the nerve may be cut near its termination.

The fascia lumborum, and at the front of the wound some of the muscular fibres of the transversalis muscle, are divided to the full extent of the division of the more superficial layers. This should be done very carefully, because in thin subjects the peritoneum is close beneath the transversalis muscle and very adherent to the intervening fascia. The outer edge of the quadratus lumborum is exposed, and if the muscle is broad it should be divided as far back as the limit of the skin incision.

The transversalis fascia will be exposed, and should be freely divided; this done, the thin, smooth, and glistening cellulo-fibrous sheath (the perinephric fascia of Zuckerkandl) containing the fatty tissue investing the kidney will bulge into the wound at the back, and the sub-peritoneal fat will be seen farther forward.

The perinephric fascia may easily be mistaken for the peritoneum by one not accustomed to operating on the kidney from the loin. It can be easily picked up by a pair of forceps, is thin, smooth, and glistening, and often flaccid. On incising it the peculiarly delicate primrose coloured fat around the kidney comes into view in all cases in which it is in a normal state. To avoid mistaking the peritoneum for it, the fascia should be cut in the back part of the wound near the border of the erector spinæ. It is always desirable, and much facilitates the enucleation of the kidney, to have a free incision in the parietes. Sometimes, however, the surgeon finds that his manipulations are made difficult, or are restricted, not by want of length of wound but by the sharp lower edge of the ligament of Henle, beneath the upper edge of the parietal incision. This is overcome by making a vertical incision through skin and muscles down to this ligament, and then carefully dividing it; or, without cutting the skin or muscles, nearly as much room is gained by cutting the edge of the ligament nearly up to the lower border of the twelfth rib from within outward, the knife being guided by the left index finger, which has pushed upwards before it the lower part of the *cul-de-sac* of the pleura. When the ilio-costal space is very narrow indeed, and the last rib is very long, and in other cases, again, where the kidney has a very high position and the thorax is very long, great difficulty may be experienced in reaching and enucleating the upper pole of the kidney. Under these circumstances I do not hesitate to remove two or more inches of the outer end of the twelfth rib. I have done this on several occasions, and always with advantage.

All bleeding vessels having been twisted or ligatured, and hæmorrhage quite stayed, the assistant should stretch the edges of the wound widely apart by suitable retractors, and the operator with a pair of blunt-ended scissors cuts, or with two pairs of dissecting forceps tears, through the circumrenal fatty capsule.

When the kidney has been fairly reached, the renal pelvis should be palpated, and then the index finger should be passed carefully over the whole of the posterior surface of the organ, and any inequality of surface, or increased hardness, or resistance at any particular spot, should be searched for. During this tactile exploration, indeed throughout the whole of the examination of the kidney, the abdominal walls of the patient should be well supported by an assistant or by well-arranged pillows, so that the kidney should not be pushed forwards by the exploring finger; and the finger and thumb of the left hand should compress the top of the ureter if a small stone has been felt in the renal pelvis, in order to prevent the calculus slipping into the tube; or, if possible, the calculus should be thus grasped to prevent its receding into one of the calyces.

If the calculus is not detected on the posterior aspect nor in the pelvis of the kidney, the fingers of the right hand are passed round the outer edge of the organ, and the front surface is felt over in the same way as the posterior. Whilst doing this, in order to give counter-resistance to the exploring finger, the kidney may be pressed against the psoas muscle, or be compressed between the finger and thumb. The upper and lower ends of the kidney should be freed and palpated in a similar manner. Despite these means, a calculus the size of a marble may escape detection. Even after the complete removal of the kidney from the body, the locality of the stone may not be made out by pressing the organ between the finger and thumb, nor by pressing upon the kidney as it lies upon a table. For this reason the kidney must be brought out between the edges of the wound on to the surface of the loin, and an inspection and a digital examination made of the interior as well as of the surface of the organ. In nothing, since its introduction, has the operation been improved so much as by doing away with the absurdly inefficient needle puncturing, and substituting for it a deliberate incision for the purpose of palpating and sounding the substance and cavities of the organ under circumstances in which the eye can readily assist and supplement the finger. No other method is equal to it, and nothing short of an incision into the renal substance affords a satisfactory exploration.

Having detected and exposed the stone, then with a scooping movement of the finger introduced through the incision in the kidney, it can be raised to the surface of the parietal wound on the point of the finger unless it be very large or branched.

Or a small scoop or a pair of slender forceps may be used for seizing and withdrawing the stone. A variety of special forceps have been made for this purpose. The finger is, however, much to be preferred, and if the incision is small the finger serves the purpose of plugging the renal wound, whilst it lacerates the renal tissue to the necessary extent. By this plan the hæmorrhage is minimised, and the rent made with the finger heals as readily as the cut. The stone may be cut down upon and extracted through either the renal substance or pelvis, according to its greater accessibility through the one part or the other. When the incision is made into the renal pelvis, the interior of the kidney can be explored, and the ureter sounded through the same incision; when the extraction is through the renal parenchyma, a separate but minute opening will, in many cases, have to be made in the renal pelvis to sound the ureter, as there is often difficulty in making the ureteral bougie or sound enter the ureter through the wound in the parenchyma. The exploration of the interior of the kidney for calculus can be, however, much more thorough and complete through an incision along the convex border of the organ than through the renal pelvis, and there is much more room for extracting the stone;—unless, indeed, as may be the case, the pelvis is stretched over the surface of the calculus, adhering to it, and the calculus is bridged over above by the thick and tough bands which may be separating the distended calyces from one another. In such a case the extraction is easier through the pelvis, and is accomplished with far less damage to the kidney (*see* Figs. 53 and 54, pp. 413 and 414, Vol. I., and Fig. 127, p. 150, Vol. II.). In every case of nephrolithotomy the ureter ought to be sounded from the kidney to the bladder before completing the operation.

If the calculus be large and branched, it may possibly be requisite to break it up into two or more fragments, and to remove the fragments separately. This has had to be done in a suppurating kidney; but it is not probable that a stone will attain such a size as to require breaking without having in its growth more or less destroyed the kidney structure. Stones much over an ounce in weight have been removed entire from a kidney not markedly enlarged without the necessity of breaking them.

In nephrolithotomy, performed as it is upon normal or nearly normal kidneys, the incised surfaces in the renal substance should always be brought together by sutures. Fine silk is the best material, and each suture is passed through the kidney substance about half an inch from the edges. There is no need of sutures, it is true, in order to obtain quick and excellent healing of wounds of the kidney; but when the renal cavity has been laid open sutures assist in preventing the escape of urine and, in any case, materially tend to check hæmorrhage. During their introduction, as also during the exploration of the interior of the organ by the operator, the renal pedicle should be compressed between the left finger and thumb of the operator, or by his assistant;* but as this empties the organ of blood the ligatures must not be tied so tight as to cut through as soon as the blood re-enters the renal artery and the kidney swells again. The incision in the renal pelvis should be closed by very fine silk sutures, passed after the manner of Lembert; only the cellular and fibrous tissue, not the mucous coat, should be penetrated by the sutures.

The **after-treatment** is very simple: a drainage tube should be left in, and the wound should be closed by sutures. These loin wounds after nephrolithotomy usually heal very quickly. Neither the escape of urine, nor the occurrence of suppuration, is usual in simple cases of nephrolithotomy. For further details of treatment the reader is referred to p. 178 *et seq.*

The **dangers of nephrolithotomy** are not great. (1) Hæmorrhage from the wounded kidney is not likely to be serious if the plan suggested above be followed. Bleeding can be readily stopped by compressing the pedicle of the kidney during the operation, by compressing the parenchyma between the fingers and thumb, or by a sponge compress as soon as the kidney is returned into the loin. No packing of any sort should, on any account, be stuffed into the wound in the kidney; it causes much pain and sometimes actual colic, as has been proved by the cessation of these symptoms immediately after the withdrawal of the plug; recurrent hæmorrhage is not unlikely to follow on the too early withdrawal; the withdrawal is so painful that Jacobson advises that an anæsthetic be given for the purpose; and it is not improbable that abscess or a renal fistula will result. A case has been recorded† in which nephrectomy was performed eighteen months after nephrolithotomy, in consequence of persisting and recurring hæmaturia, due to a renal pelvic papilloma which co-existed with the calculus. Desnos and Mayo Robson have reported cases of uncontrollable hæmorrhages during exploration of the kidney by incision. (2) Cellulitis may follow the operation, but with due precaution as to asepticity and drainage this will almost certainly be escaped. (3) Renal abscess might possibly follow the operation as the result of wounding an organ already long irritated by the presence of a calculus, but it is improbable. (4) A renal fistula or a more superficial purulent fistula may follow; but this is rather exceptional. A urinary fistula has followed in about 5 per cent. of my nephrolithotomies up to the present time, and the fistula has not been permanent in all of these. (5) Uræmia or anuria may temporarily occur if the opposite kidney is blocked or distended by calculus or some other cause, and if the function of the kidney operated upon is suspended as the effect of shock. (6) A lumbar hernia may follow, just as a ventral one may follow a cœliotomy. I have known, however, of only one or two cases. (7) It is commonly stated that there is danger of wounding the pleura when incising the parietes. I do not think there is any probability whatever of doing so, provided the oblique lumbo-inguinal incision is followed, and the posterior and upper end of it is kept to the outer border of the erector spinæ muscle half an inch to three-quarters of an inch below the twelfth rib. It is only immediately on each side of the spinal column that the pleural sac descends below the twelfth rib: at the outer border of the erector muscles it does not reach to the lower edge of the last rib. It is only by carrying the incision above or even up to the lower border of the twelfth rib, as is done when a vertical incision is employed, or by omitting to notice the absence or abnormal shortness of the twelfth rib and then commencing the oblique incision immediately below the eleventh rib, that this accident can occur.

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* Dr. Cumston has devised some clamp forceps for the purpose. See *Annals of Surgery*, 1897, vol. xxvi., p. 326.

† Battle: *Brit. Med. Journ.*, 1895.

In the case in which Dumreicher of Vienna accidentally opened the pleural cavity the twelfth rib was rudimentary and the pleura descended below the lower edge of the eleventh rib.

Difficulties of the operation.—*The enucleation of the kidney.* The chief causes of difficulty in exposing the kidney are stoutness, great depth of loin, narrowness of the ilio-costal space; the condensation and induration of the tissues around the kidney from prolonged irritation within the organ, leading to tough adhesions between the perinephric tissue and the fibrous capsule; a high position of the kidney so that its lower pole is above the twelfth rib; and, to a less extent, the downward displacement of the kidney below the iliac crest by the liver or spleen. Mobility of the kidney does not cause any real difficulty, as the organ can be steadied by the hand of a good assistant.

Flatulent distension may cause the colon to bulge into the wound and get into the way of the operator; this, however, is easily overcome by pressing back the bowel with a sponge and keeping the sponge retracted by means of a deep retractor.

One of the commonest impediments to the free manipulation of the upper pole of the kidney when *in situ* I have found to be the lower edge of the ligament of Henle, felt as a thin, tense, very resisting edge below the last rib at the back of the wound, and it is sometimes quite surprising how the difficulty vanishes as soon as this tense structure is divided. This is easily done with a straight probe-pointed bistoury passed along the left index finger; if at the same time the finger-tip presses upwards the tissues on the deep aspect of the ligament, there is no fear of wounding the pleural *cul-de-sac*.

Most of the above-mentioned causes of difficulty will be overcome by making the parietal incision not of any prescribed length, but of sufficient length to meet the requirements of the individual case, and by carefully twisting off with the fingers or forceps the redundant lumps of fatty tissue which so much hamper manipulation in stout and deep-loined persons.

To separate tough adhesions the careful use of a pair of blunt-ended scissors or of a scalpel should supplement the use of the fingers. It is much better to deliberately cut through than to tear off many of these firm connections. By forcible tearing there is danger of lacerating a branch of the renal artery or vein or the renal parenchyma, or even the ureter or renal pelvis.

When the liver or spleen pushes the kidney down to or below the brim of the false pelvis, it and not the kidney will come into view; and the peritoneum will be opened if either is mistaken for the kidney. The absence of perinephric fatty tissue and the fact that the solid organ is seen through a thin membrane should prevent the error. The kidney will easily be drawn up into the area of the operation wound if the liver or spleen, as the case may be, is pushed upwards beneath the ribs, and retained there by means of a finger or a retractor.

There ought to be but little difficulty in detecting and removing the calculus when the kidney is in a normal condition, if the directions given in the chapter on Renal Calculus are followed (*see ante*, p. 133 *et seq.*).

Modifications of the operation. 1. **As to the parietal incision.**—Other lines of incision have been employed; and when the ilio-costal space is very narrow, or the lower end of the kidney does not extend below the twelfth rib, an addition to the usual oblique lumbo-iliac incision gives increased space. This is made by converting the lumbar incision into a T-shaped one by cutting through the tissues in a direction towards the crest of the ilium; or by joining with the oblique incision one ascending over the last rib from about the middle of the original wound. These vertical incisions through skin and muscles are, however, very seldom required if the ligament of Henle is divided up to the lower border of the last rib in the manner above described.

The incision recommended by Israel is the same as that which I employed in my first operation in February, 1880. For exposing the ureter in its whole length by an extra-peritoneal method, Israel prolonged this incision to the middle of Poupart's ligament, and then turned it towards the middle line, ending it at the outer border of the rectus muscle. Some surgeons carry a short transverse incision forwards from the lower end of the oblique one (Treves, "A Manual of Operative Surgery").

Recently Mayo Robson of Leeds (April, 1898 *) and Abbe of New York, following the plan recommended by Greig Smith and McBurney for other abdominal operations, have advocated and practised the method of splitting the several muscles of the abdominal wall in the course of their fibres, for exploring, operating upon, and removing the kidney and ureter.

Mayo Robson describes the operation in the following words: "The incision, beginning to the inner side of the anterior superior spine of the ilium, is carried backwards obliquely towards the tip of the last rib. The fibres of the external oblique and its aponeurosis are then split and retracted, thus exposing the internal oblique muscle, the muscular fasciculi of which are split in a line between the ninth costal cartilage and the posterior superior spine of the ilium, in which position they are longer than in front of or behind that line. When the fingers are pushed through the internal oblique to spilt it, the fibres of the transversalis are pierced and can be retracted along with the oblique muscle. A diamond-shaped space is thus formed, at the bottom of which is seen the transversalis fascia, which is then incised, exposing the perirenal fat, and on pushing the fingers through this the kidney is easily reached in whatever position it may lie. If needful, the whole hand may be introduced into the circumrenal space and the kidney can be grasped and freely manipulated, the retractors for the moment being withdrawn. If the vessels are moderately long, and in all cases of movable kidney, the organ may be brought through the wound and explored by incision or by needling, or it may be examined by the selenium screen and the Röntgen rays. Should a calculus be found, it can be extracted and the wound sutured before the organ is returned."

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* Mayo Robson: *Lancet*, May 14, 1898. A paper read before the Leeds and West Riding Medico-Chirurgical Society on April 22, 1898.

The advantages claimed for this method of exploring the kidney are *inter alia:* (1) There is no division of muscle, and therefore no weakening of the abdominal wall immediate or remote; (2) no vessels are divided; (3) no nerves are severed; (4) the operation is done with the patient lying on the back, to the great convenience of the anæsthetist, the operator, and his assistants, and to the manifest advantage of the patient, who is saved much unnecessary disturbance; (5) the great saving of time as well as the diminution of hæmorrhage means lessening of shock, thus rendering operation feasible when it otherwise might be questionable.

"If it be found necessary to extend the opening—for instance, in case of operation on the ureter deeply in the pelvis—it is easily accomplished by departing slightly from the principle here advocated and dividing the deep plane of fibres and further splitting the external oblique towards Poupart's ligament. The internal oblique will then require suturing to bring together the divided edges. In this way the ureter, even to its entrance to the bladder, may be fully exposed to sight as well as touch."

2. **As to the examination of the kidney.**—Howse, in 1883, rightly urged the examination of the anterior surface of the kidney with the finger pressing the organ back against the psoas muscle as being a safer, easier, and more certain method of examination than the method of making numerous punctures with a needle in different directions through the kidney substance.*

Since the publication of Kendal Frank's case † in which on

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* *Clin. Trans.*, vol. xvi., p. 99.

† *Brit. Med. Journ.*, March 31st, 1888.

April 5th, 1887, he, adopting the plan I had recommended in 1884, incised the kidney along its convex border and found a stone which had evaded all the other methods of search which he employed, the exploration of the interior by means of an incision of the parenchyma has gradually gained favour. No examination ought to be considered complete unless the interior as well as the surface of the kidney is palpated and inspected. This examination by incision ought not to be made until the kidney has been brought out upon the surface of the loin in every case in which the conformation of the loin permits of it, and this it does in most persons except the very stout.

The precise mode of making this examination of the interior of the kidney varies with different surgeons; it also rightly varies, or should be varied, according to the position of the calculus. Albarran says that the real difficulty in laying well open the two collector calyces—superior and inferior—has induced many authors to extol and recommend pyelotomy (or incision of the renal pelvis) for exploring the calyces. Legueu has proposed, when a calculus is suspected, to make two incisions along the convex border of the kidney—one near the superior, the other near the inferior extremity—leaving the intermediate part of the parenchyma uncut.

Jordan Lloyd (*Practitioner*, xxxix. 173) recommends a plan which has received high praise from Jacobson, who says that to it he (Jacobson) owes the finding of a calculus in one case in which the stone lay, not in the pelvis, but deeply embedded in an upper calyx, and thinks "it is to Mr. Jordan Lloyd that we owe directions for systematically exploring the kidney." This method, in Mr. Lloyd's words, is as follows: "When the kidney is exposed through a lumbar wound, I puncture its lower end with a long bladed tenotome in a direction upwards and inwards, making for the lowest of the calyces. If the surgeon is observant, and his knife is keen, he will readily appreciate the moment when a cavity is struck by the altered resistance offered to the puncturing instrument. . . . It is important, because a tenotome may be pushed up to its handle in a normal kidney without tapping its interior cavity, having travelled along the kidney substance rather than through it. Into this opening I pass a child's bladder sound, and systematically explore the whole of the pelvis." It is advised that the sound should be passed at once to the uppermost part of the renal cavity, a distance of nearly four inches in a normal kidney, and with the point of the sound search should be made of each calyx by turning in all directions as it is withdrawn.

This plan has never recommended itself to me, for the following reasons: (1) a small stone in the parenchyma not in a calyx will escape detection; (2) a calculus in an upper calyx cannot be removed by this incision in the kidney made for the exploration; (3) if the diagnosis is uncertain, some other lesion—such as a tuberculous focus, an abscess, cyst, or small neoplasm—may be present instead of a calculus, and then it is desirable to explore the renal parenchyma as thoroughly as possible through a free incision in the convex border, instead of merely making a small incision from one end of the kidney into the renal pelvis; (4) the risk of wounding a large vessel in the hilum, and not being able to see the source of the hæmorrhage. The method of bringing the kidney on to the loin and introducing the finger through an incision in its convex border enables such an examination by sight and touch to be made as to render it impossible, with care, for a calculus, however small, in either renal substance or cavity to escape detection. The most complete and, so far as the future integrity of the kidney is concerned, the safest way of exploring the interior of the kidney is by such an incision.

Arthur Barth, Tuffier, and others have shown that the extension of parenchymal degeneration surrounding a nephrotomy wound depends in the first place on the extent of the injury to the vessels; and that to minimise this injury the longitudinal convex marginal incision, recommended by Gigon in 1856 and now used by many surgeons, is the best mode of procedure.

Barth * has published a description of a specimen, taken from a woman aged thirty-one, on whom Küster had performed probatory nephrotomy for suspected tuberculosis of right kidney. His account of the anatomical details (with plates) confirms the conditions noted by this author in his experiments. Mr. Foulerton and Mr. Hillier microscopically examined for me sections cut in paraffin of the kidney of a woman upon whom, several months before her death from sarcoma of the ilium, I had performed an exploratory nephrotomy. Their report shows that the greater amount of degeneration was on the side of the scar furthest away from the convex margin, that is on the side where the vessels were largest:

"The position of the incision is marked on the surface of

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* *Archiv f. klin. Chir. von Langenbeck*, 1893, xlvi., 418.

the kidney by a deep fissure running along the posterior surface close to and parallel with the convex border.

"On section of the kidney the cicatrix is seen to extend from the surface forwards and inwards towards the pelvis.

"On one side of the cicatrix, near the surface of the kidney, there is a wedge-shaped patch of yellow tissue, which corresponds with an area of cloudy degeneration.

"On microscopic examination the cicatrix appears to be constituted of vascular fibrous tissue, in which in places there can be seen the remains of glomeruli and tubules, the epithelium of which has undergone advanced degenerative changes. On one side of the cicatrix is a wedge-shaped area of advanced degeneration already referred to. Stained by logwood, the section still shows the general structure of glomeruli and tubules, but almost all trace of organised epithelium is lost, being replaced by badly-staining homogeneous material in which traces of nuclei can be seen.

"On the other side of the scar the kidney substance shows little alteration beyond some increase of interstitial connective tissue in the immediate neighbourhood of the scar."

THE ABDOMINO-LUMBAR NEPHROLITHOTOMY.

To the general surgeon with a far from inconsiderable experience in all kinds of abdominal surgery it seemed incredible, indeed impossible, that it could ever be seriously proposed to open the abdomen to perform nephrolithotomy, still less that it would be gravely argued that such a method was superior to the simple direct and extra-peritoneal procedure through the loin. Such, however, is the case, and as Mr. Jacobson writes, "As might be expected, this proposal has come from a specialist in abdominal surgery."

It is hardly likely that such a proposal, had it come from one less well known and less skilful in abdominal operations than Mr. Thornton, would have received any great amount of attention. As it is, the abdomino-lumbar method has been frequently and widely discussed, ardently defended by its proposer, but rejected by nearly all other surgeons of experience in renal operations; and finding few, if any, supporters at the present time, it is destined soon to fall into the limbo of history. In deference to the eminence as an abdominal specialist of its author, it, however, has a claim to be considered here.

The operation.—The abdomen is opened by an incision (known as Langenbuch's incision) made along the semi-lunar line over the kidney to be operated upon.

"The incision should begin just below the ribs, a narrow hand's breadth from the middle line, and be carried down for about four inches, so as to admit the operator's hand without bruising the parietes. After the division of the linea semilunaris, and the peritoneum has been opened, the hand should be introduced and passed over to the opposite side of the abdomen for the examination of the opposite kidney and ureter. When the healthy condition of this kidney and ureter is assured as far as it can be by intra-peritoneal palpation, the hand is withdrawn, and a flat carbolised sponge is introduced to keep back and cover the intestines, and to protect the colon during the second step of the operation; then the suspected kidney and ureter are examined, the calculus is sought for by the fingers of the hand so introduced, and by means of this hand the kidney and stone are fixed. The second step of the operation consists in cutting down upon the stone from the loin. This is done by merely making an opening in the loin tissues, directly down upon the stone, large enough to introduce the finger and the necessary forceps for the extraction of the stone. The opening of the peritoneum is primarily exploratory and diagnostic, and secondarily of great advantage in enabling the stone to be accurately and quickly reached and extracted. The loin incision does not interfere with the peritoneum, and no wound is made from the peritoneal surface of the kidney."* Mr. Thornton then goes on to point out wherein he considers this stab-like wound from the loin has advantages over the wide and deliberate exposure of the kidney in the ordinary incision of lumbar nephrolithotomy.

There is no need for me to enter into a full statement of the objections to Mr. Thornton's operation or a thorough criticism of what I believe to be the fallacies of his arguments in support of it and in opposition to the lumbar method. This has been exhaustively and ably done by Mr. Jacobson in his admirable work on "The Operations of Surgery" (3rd ed., p. 737). I will very briefly notice one or two essential points only.

It is clear from Mr. Thornton's own description that the important feature of his operation is, after all, the removal of the calculus *by an extra-peritoneal incision from the loin*, without opening the peritoneum from the lumbar aspect, and without making any wound into or on to the kidney from the peritoneal surface. Two questions thus arise: (*a*) Why open the abdomen at all, seeing that the incision into the kidney and the removal of the calculus are effected through the loin? and (*b*) Why so small an incision in the loin?

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* Thornton, "Harveian Lectures." Lect. I., p. 34.

(*a*) The reply is that the trans-peritoneal examination (1) confirms the diagnosis as to the presence of a calculus before cutting into the kidney; (2) that it prevents an operation being performed upon the wrong kidney, when the pain caused by the calculus is transferred to the opposite side; (3) that it allows of the other kidney and both ureters being thoroughly examined throughout their whole course; and (4) that, by fixing the kidney and stone with the left hand in the abdominal cavity, the stone can be accurately and quickly reached and extracted.

Experience, however, has repeatedly shown: (1) That a calculus weighing thirty or forty grains or more, to say nothing of smaller calculi, have escaped every method of exploration except palpation and inspection after a free incision has been made into the renal parenchyma. I have on several occasions been able to convince bystanders on this point when operating in the theatre of the Middlesex Hospital and in private. Other surgeons have had the same experience. There is no longer any room whatever to doubt the insufficiency of palpation of the unopened kidney for the detection of calculus in many cases, and those often amongst the most severe.

(2) That the theory of sympathetic pain, or the transference of pain to the opposite kidney, not only needs confirmation but is unsound in theory and unsafe in practice (*see* "Hunterian Lectures," p. 69 *et seq.*).

(3) That the mere presence of a second kidney is no criterion of the organ being adequate to meet the requirements of the body. Many of the diseases which render the renal function most inadequate are consistent with the normal size and outline of the organ. A kidney may be in a condition of advanced chronic nephritis requiring the microscope for its detection, or it may be filled with tubercle, or occupied by a small alveolar cancer, or in a state of progressing nephrectasis, or otherwise defective, without giving evidence of being so when palpated in the body. As to the ureters, one or other may be completely obstructed in other ways than by a hard detectable calculus without giving any sign of its condition through the peritoneum. Moreover, the detection of the ureters with the hand passed across the abdomen is by no means a

simple matter; and in the female they cannot be so examined "throughout their whole course," because that portion which is within the broad ligament does not permit of it.

Further, in reference to the question of the advisability of performing nephrolithotomy, the condition of the opposite kidney is of importance chiefly in this way, that any disease of it, still more its atrophy or absence, make the removal of a calculus from the good organ all the more imperative, and that too at as early a period as possible, before the stone has produced any serious disorganisation of the kidney. Even in considering the question of nephrectomy the test is both unreliable and unnecessary. Unreliable for the reasons just given; unnecessary because, if the clinical history and symptoms do not inform us (as they so often do) as to the existence and state of the opposite organ, there is the ureteral catheter and cystoscope which enable the presence of the other kidney and, what is of equal importance, the character of the urine it excretes to be ascertained. If the evidence afforded by these means is not conclusive, the surgeon has it in his power to gain all the information he requires by performing nephrotresis as a primary operation and nephrectomy at a later period, when proof of the healthy or sufficiently healthy action of the second kidney has been obtained by the measurement and examination of the urine discharged through the bladder after the fistulous opening of the condemned kidney has been established.

(4) The advantages of fixing the kidney and stone with the hand in the abdominal cavity in respect to the accuracy and completeness of the search and the facility of removal of the stone, are not comparable with the incision of the kidney after it has been brought on to the loin under the direction of the eye as well as of the hand.

(*b*) With regard to the small loin incision and the stab through the kidney on to the stone, so much extolled by Mr. Thornton, the most overwhelming argument against it is a remark of his own, viz. "that it is essential for successful practise of surgery to be able to see what you are doing."

Most certainly in the exploration of the kidney and the performance of nephrolithotomy the leading object should be to expose the kidney to the fullest view possible, and to explore with the finger the whole interior and parenchyma of the organ, and this cannot be done through a stab wound in the loin.

CHAPTER XXIX.

OPERATIONS ON THE KIDNEY, AND THE METHODS OF PERFORMING THEM.

(*Continued.*)

NEPHROTOMY.

NEPHROTOMY is an operation of very ancient date, but until the last quarter of a century or less it was only performed for the evacuation of pus; although the chance removal of a stone occasionally happened in cases of suppurative nephrectasis, and of perinephric abscess due to the bursting of a pyo-nephrosis.

At the present time it is performed in five very different classes of cases: (1) as an exploratory operation when the kidney is neither suppurating nor sacculated nor distended; (2) when the kidney is in a state of sacculation, or suppuration, or both, *i.e.* in nephrectasis or in pyelitis; (3) when the kidney is enlarged in some other way than by nephrectasis; (4) to give exit to urine and to allow of the search for a calculus in cases of obstructive anuria; (5) the simple division or puncture of the capsule, with or without a certain amount of decortication of the kidney, is performed for the relief of great renal pain due to mechanical congestion, inflammatory hyperæmia, or sub-capsular extravasation of blood.

The term nephrotomy has also been applied, but improperly so, to the incision in the lumbar region, either for the evacuation of pus in perinephric suppuration or for the purpose of examining the kidney without incising it. The name is not used in this sense in this work.

1. Nephrotomy should be performed as an exploratory operation when the kidney is not enlarged, if there be persistent lumbar pain with or without paroxysms associated with hæmaturia or pyuria. Such symptoms may be due to a variety of causes, and if they are not relieved by dietetic, hygienic, and medicinal treatment, the kidney should be explored in the manner described at p. 131 *et seq.* All such cases are likely to be mistaken for calculus, though tubercle new growth (not large enough to project the

surface of the kidney), traumatic or other abscess, cysts, angeioma, intrarenal hæmatoma, mechanical congestion from tension of the renal vessels, and certain cases of nephritis with high tension, albuminuria, and perhaps renal casts, may be the actual cause of the symptoms, and not calculus. R. Harrison has suggested that a limited incision into the renal cortex should be practised in certain cases of *scarlatinal nephritis*, when death is imminent from suppression of urine due to a high degree of vascular and tubular infarction; and also in obstinate chronic forms of nephritis when the albumen does not diminish and the disorganisation of the kidney is progressive.

2. Nephrotomy is performed for nephrectasis from a variety of causes: in some cases there is suppuration, in some not. Calculus and tubercle play a large part in producing renal enlargements. Nephrotomy is the operation for certain cases of calculous hydro-nephrosis; for some cases of hydro-nephrosis (if not too far advanced) due to stricture, valve, or an abnormal attachment of the ureter to the renal pelvis, if the obstruction can be remedied by a plastic operation; in some other cases for hydro-nephrosis, when the patient will not submit to nephrectomy, and when the cyst rapidly refills after puncture; for pyo-nephrosis of calculous origin when not so far advanced as to require nephrectomy; in certain cases of tuberculous pyo-nephrosis, when the patient will not consent or is not strong enough to undergo nephrectomy; as well as when the opposite kidney is unequal to discharge the duties of both organs, especially during the stress of recovery from a serious operation like nephrectomy. It is also the operation for traumatic pyo-nephrosis, and other varieties of pyo-nephrosis, especially for that form which is the result of ascending pyelo-nephrosis if both kidneys are involved, or if only one is affected, provided the cause in the lower urinary organs is a remediable one.

3. For enlargements of the kidney other than of the nature of nephrectasis, it is performed for hydatid cyst when from the adhesions or from the number and size of the daughter cysts the contents cannot be evacuated through a drainage tube; for circumscribed abscess; for solitary cysts other than the hydatid cyst; and in *exceptional* cases of polycystic disease. I have performed nephrotomy in these cases for the relief of severe pain due to tension—opening several of the largest cysts and evacuating their contents. In one case I did this on both kidneys on

two following days, and though the patient died of his disease he derived much relief from pain and sickness from the operations.

4. To give exit to the urine in cases of anuria from obstructive causes, of which the most common is calculus. In calculous anuria the incision of the kidney will serve for the exploration for stone as well as for the relief of renal retention. Whether nephrectomy rather than nephrotomy will require to be done will depend upon the irremovability or otherwise of the obstruction.

5. *Incision of the renal capsule.*—There is still another class in which an incision is made all along the convex border of the kidney, but merely through the capsule, not dividing the parenchyma of the kidney; this is done to relieve great renal pain resulting from congestion arising either from a mechanical cause, or from nephritis with high tension, *i.e.* renal hyperæmia of inflammatory origin. Klemperer and Newman* recommend this modified form of nephrotomy in cases of mechanical congestion due to torsion of the renal pedicle in which such symptoms as the following are excited: violent renal pains amounting almost to colic, and associated with hæmaturia or albuminuria, with or without the discharge of urinary casts. For this purpose the operation consists in detaching the capsule from the kidney substance for some little distance on each side of the incision, and then fixing the kidney so as to prevent subsequent kinking or rotation of the organ.

R. Harrison† has recommended that three or four punctures should be made in different parts of the renal capsule after exposing the kidney in certain cases of nephritis with renal tension with albuminuria. I have performed this modified form of nephrotomy with great benefit in three or four cases of subcapsular hæmorrhage, in two of them certainly of a traumatic origin.

The operation.—The parietal incision is precisely the same as for lumbar colotomy, except that, as the kidney is situated a little nearer the median line than the colon, the deep part of the wound should be kept a little posterior to that in colotomy. A slightly oblique incision should be made in the ilio-costal interspace, beginning over the outer edge of the erector spinæ, and continuing it forwards for three and a half inches or more. It should be continued forwards far enough to afford ample room for the deep manipulations. After dividing the skin, superficial fat, and fascia, the outer border of the latissimus dorsi and the posterior border of the external oblique of the abdomen will be brought into view, and should be divided to the full extent of the superficial incision. It is unnecessary to open the sheath of the erector spinæ. Next, the internal oblique and the aponeurosis of the transversalis must be cut through, whereupon the outer border of the quadratus lumborum will be seen, and may be divided if the muscle is very broad or in the way; the deep layer of the lumbar aponeurosis must be divided. No grooved director or other guide is necessary to reach this stage; a scalpel and a pair of dissecting forceps for the operator, and two well-formed deep retractors for his assistant, being all the instruments required, beyond two or more pairs of torsion pressure forceps to control hæmorrhage from vessels cut in the division of the parietes. The circumrenal fatty tissue, having thus been reached, will in all probability be found condensed and otherwise much altered by the inflammatory process which has gone on in and around the kidney; and if the operation be done for abscess of the kidney, suppurative changes will perhaps have taken place in the structures forming the bed of the kidney. When this tissue has been divided the distended pelvis, cyst, or abscess (as the case may be) of the kidney should be either first tapped or at once cut into, its contents evacuated, and the cavity well irrigated with some disinfecting solution. If it be thought desirable, as in certain cases of hydro-nephrosis and cysts of the kidney it is, to stitch the cut edges of the cyst to the edges of the skin (nephrotresis) this should now be done. Four or five sutures will be ample for this purpose. A drainage tube should be inserted into the kidney if the organ is very much dilated and sacculated, but not otherwise, and the greater part of the wound should be left to granulate, though the anterior and posterior extremities of the parietal incision may be brought together by a few sutures with advantage.

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* Newman: *Clin. Soc. Trans.*, vol. xxx., 1897.

† *Trans. Med. Soc.*, 1897.

The operation varies in details very much according to the class of case for which it is performed.

1. When employed for the relief of symptoms caused by passive congestion due to torsion of the pedicle, or to nephritis with great tension, or to renal compression caused by subcapsular hæmorrhage, the capsule only is divided. This is best done by an incision from end to end of the organ, peeling off the cut edges of the capsule from the cortex for a third or half an inch. If the kidney is movable the cut edges of the capsule should

be sutured to the deep structures of the abdominal wall on either side of the oblique incision in the parietes; the operation in these cases, therefore, thus practically becomes nephropexy by the method of decortication. When the cause of the symptoms is scarlatinal nephritis R. Harrison has recommended either a few punctures through the capsule into different parts of the kidney or a single deliberate incision into the parenchyma.

2. When the kidney is neither suppurating nor dilated and the nephrotomy is undertaken for an exploratory purpose the steps of the operation and the method of search are precisely the same in technique as when undertaken for exploring the kidney and ureter for calculus (*see* pp. 133 and 134).

3. When the cause of the enlargement of the kidney is a simple or hydatid cyst, or polycystic disease, the course to be adopted will depend upon several conditions which have been described under the treatment of these various diseases. A simple or hydatid cyst will be excised if possible; if not, its walls, after being trimmed off as much as possible, should be stitched to the cut edges of the parietes and the cavity drained.

In certain cases of polycystic kidney nephrectomy will be the ultimate result of the exposure of the kidney, but in other cases in which it is known or suspected that the opposite kidney is similarly affected all that will be done is to incise the superficial and protuberant wall of a few of the largest cysts and then to close the wound in the parietes around a large drainage tube reaching as deep as the kidney. An abscess should be opened and drained; a tuberculous mass, if small, erased and the scraped surfaces rubbed with iodoform emulsion; a small, well-circumscribed non-malignant growth should be excised by cutting out a wedge of tissue and bringing the surfaces together with sutures; or partial nephrectomy may have to be performed. I have opened, scraped out, and rubbed with iodoform as many as five and six small abscesses with a successful result, and in several cases I have cut out two, three, and four wedges of renal tissue for abscesses with concretions within them or for tuberculous foci.

4. When nephrotomy is performed for calculous anuria it is necessary to give relief to the engorged parenchyma as well as exit to the urine, if any is pent up in the renal cavity.

The kidney, which will probably be enormously engorged and swollen, ought therefore to be incised along the central part of its convex border into the calyces. Through this incision the surgeon should pass his finger and thoroughly explore every calyx and every portion of the parenchyma for stone; then the ureter must be sounded throughout its whole length, and that too whether one or more calculi have been found and removed from the kidney or not. The next step of the operation will depend upon whether the cause of the obstruction is a removable one or not, and if removable, whether it is removed at the time or is left to be removed at a subsequent operation.

If the renal pelvis and ureter are left quite free and unobstructed, nothing more should be done but to close the parietal wound in the usual way, leaving a large drain tube or two tubes extending down to but not passing into the kidney. Sutures are not to be recommended in these cases unless hæmorrhage from the divided renal parenchyma is too free and cannot be controlled by temporary compression with sponges before closing the external wound. In that event they may be needed to assist in checking bleeding, otherwise it is desirable to leave the renal wound unclosed by stitches to allow of the free draining away of urine and blood.

The same course should be adopted if there is left behind an obstruction which may be removed on an early subsequent occasion, when the nature of the operation for its removal or the condition of the patient does not permit of an extension of the operative procedure necessary for its extraction at the time, such, for instance, as when there is a calculus in some part of the ureter below the pelvic brim.

If, on the contrary, there is an obstruction to the natural outflow of the urine from the kidney which will either be permanent or is unlikely to be removed for some length of time, then it will be requisite to convert the nephrotomy into nephrotresis by stitching the cut edges of the renal parenchyma to the wound in the skin if the kidney is much dilated and the secreting tissue very thin; or, when the renal parenchyma is thick and the cavity not distended, by making an incision into the renal pelvis and suturing its edges to the edges of the skin, if the pelvis is sufficiently expanded to permit of this, and if not, to some of the deeper structures of the parietal incision. When the nephrotresis is thus made to involve the renal pelvis it is still not desirable to close the incision in the parenchyma with sutures, but to pass a drainage tube into the perinephric wound by the side of the attached renal pelvis: in this way the relief afforded by the division of the capsule and parenchyma will be continued.

In no case when the obstruction is permanent and near the bladder is it desirable to divide the ureter and suture the cut end to the skin in the loin, because to do so would be to destroy the possibility in future of grafting the ureter into the bladder.

5. Perhaps the most frequent cases, and certainly amongst them are the most difficult and dangerous cases, for which nephrotomy is performed are those in which the kidney is either suppurating or dilated or suppurating and dilated. It is in this group that we so frequently meet with conditions where we must decide whether to excise the kidney or leave the patient to recover with the certainty, or all but certainty, of a permanent renal fistula, or the great probability of having a recurrence or continuance of the original disease. It is amongst this group that we meet with perinephric abscess and diffuse suppuration; with circumrenal fibro-lipomatous induration and hypertrophy; with firm adhesions of the condensed surrounding tissues to the renal capsule, fixing the organ as in a setting of plaster of Paris, and sometimes making it very difficult with eye or finger to differentiate the kidney from the altered tissues embedding it. It is amongst this group that we find enormous kidneys with thick, hard, sclerosed parenchyma, yet with greatly dilated and sacculated cavities, the renal cavity being bulged into numerous largely expanded pouches separated off from one another by dense thick fibrous septa. In such a kidney may be found multiple calculi, bathed in pus and urine or adherent to the renal tissues, one or more in each pouch, or one huge calculus with a long branch projecting into each of the distended calyces; or the kidney may be converted into a huge multilocular abscess with large loculi bulging the surface of the organ and stuffed with whitish-yellow, or yellowish-green, or marbled-yellow and plum-coloured pultaceous material.

On the other hand, the kidney, though enlarged and dilated, may be surrounded, with uninflamed, perfectly natural cellulo-fatty tissue, only normal or less than normal in amount, which is most readily peeled off from the kidney capsule, leaving only a thin and even flaccid layer of renal tissue covering the contained urine, or urine and pus, or pus or blood. Indeed, in some cases care has to be used in dividing the loin tissues whether they themselves are bulged or not, otherwise the renal cavity is opened before the surgeon is aware that he has cut through the thin layer of renal tissue forming the wall of the hydro- or pyo-nephrosis.

When these dilated or suppurating kidneys are operated upon their general character will be revealed by their colour, consistence, and outline of surface, as soon as the posterior surface of the organ is exposed. To reach this the dissection may have been easy or difficult—through natural or greatly condensed and hypertrophied circumrenal tissue—but as soon as the kidney is fairly exposed, its size and degree of fixity should be made out as far as possible. When of very large size it extends far up under the ribs and vault of the diaphragm, and when through its incorporation with the circumrenal fat it is very adherent to colon, peritoneum, and abdominal walls, it will not be desirable to attempt to enucleate it and draw it on to the surface of the loin—until or unless it has been decided to abandon the nephrotomy and substitute for it nephrectomy.

In every case, however, in which the size and the character of the connections will allow of it, it is much the best to bring the kidney out on to the surface and examine it there. This procedure will often be facilitated by drawing off the fluid contents with a trocar or cannula, by one or several introductions, according as the dilated cavity is single or multilocular.

If the kidney cannot be withdrawn through the wound before it is punctured, or if it is punctured in the process of withdrawing it, the wound cavity should be protected against the entry of any of the contents of the kidney by packing sponges between the kidney and the cut edges of the parietes.

After emptying the organ as far as possible of its contents an incision should be made into the thinnest part of the kidney which presents, and through this the surgeon should explore the whole of the renal interior for calculus. The incision should be enlarged, or other incisions should be made into other parts if necessary, to let out fluid or to examine a pouch or pouches, if any there be, shut off by septa from the rest of the interior; the septa themselves should be broken down by the finger, aided, if necessary, by a blunt probe-ended bistoury passed along the left index finger.

Tuffier points out the necessity of carefully examining and exploring the septa which separate the several pouches from the renal pelvis and from one another, because of the minute abscesses which sometimes are situated in them, and which, if overlooked, prove an obstacle to recovery. He mentions having had to excise the kidney in two cases in which nephrotomy had been performed some weeks before. The large collections had been opened and drained, but chronic septicæmia from these little, overlooked abscesses in the septa between the calyces occurred, and was only cured by the removal of the kidney.

All calculi, fragments of calculi, and calcareous grit must be removed; solid or semi-solid pultaceous matter, which is often very adherent and difficult to detach, must be removed with a scoop or finger, and after all has been cleared away the renal cavity must be well irrigated with hot boracic or very feebly carbolised (1 in 500) solution.

The patency and general state of the ureter should be ascertained, as upon this may largely depend the question of nephrectomy, either immediate or secondary. No sutures should be used on the kidney in these cases. A large drain tube should be inserted and the parietal wound should not be entirely closed, but a portion around the drain tube should be left open for increased drainage, to heal by granulation.

In cases of pyelitis or pyelo-nephritis without dilatation and enlargement in which nephrotomy is performed for the extraction of a calculus, the steps of the operation are exactly the same as those of nephrolithotomy. It is undesirable, however, if the septic condition of the kidney is well marked, to attempt to obtain primary healing. It is therefore useless to close the incision of the kidney substance with sutures, though the small incision in the renal pelvis, if one is made for the purpose of passing the ureteral sound or bougie to the bladder, may properly be closed by one or two fine silk sutures. The sutures should be passed after the manner of Lembert, and so as not to penetrate the mucous membrane.

The difficulties and dangers of nephrotomy.—These may be considered in two groups, viz. (1) those from conditions outside the kidney and (2) those from conditions within it.

(1) The *difficulties met with outside the kidney* are due to the changes which are brought about in the perinephric tissues by long-standing irritation and inflammation within the kidney.

The condensation, hypertrophy and induration of the fibro-lipomatous investment of the kidney sometimes make it very difficult indeed to lay bare any part of the organ. This altered tissue becomes toughly and inseparably adherent to the renal capsule, grows into the hilum, spreads along the spaces between the calyces and apices of the pyramids, and in some rare cases converts the parenchymatous substance of the kidney into fatty tissue. In such a condition it is not possible to expose the kidney, except by stripping off its proper fibrous capsule, and in doing so it is more than likely, when the renal parenchyma is thin, that the tissues will give way and the contents of the renal cavity will escape into the wound. In a deep loin and a very fat person these changes may make it difficult or quite impossible to distinguish the kidney, especially if it be a small, shrunken, pyo-nephrotic organ, or if the kidney, having ulcerated, has burst and discharged its contents into the circumrenal tissue. In some cases an abscess is formed in the perinephric tissue, and this is followed by a fistulous channel which extends from the kidney cavity to the surface of the loin, whilst a dense wall of tough tissue surrounds the fistulous track; or a calculus or calculi may have escaped and be lying in a pus-secreting space surrounded by fibro-lipomatous tissue of the toughest and hardest nature.

In a stout person with a deep loin it may be quite impossible to distinguish the kidney at all by touch; whilst the resisting nature of the tissues and the depth of the wound make it impossible, except through a very extensive incision, and perhaps only after the excision of the last rib, to bring the kidney within sight.

A good illustration of this was afforded by a male patient from whom, in February, 1897, I excised the last rib in order to remove from his kidney several fragments of calculus which were assisting to keep up a very bad fistula. A year later I had to excise portions of the ninth, tenth, and eleventh ribs to effect the removal of other fragments of calculi, and to enable this long fistulous track to close; this it ultimately did, and the patient quite recovered, and has remained in excellent health since.

The history of the case is briefly this. An abscess formed and was opened between the eighth and ninth ribs, three weeks after nephrotomy by another surgeon at Christmas, 1895. At the original operation some large pieces of calculus were extracted from the kidney. A fistula with a double opening ultimately followed; one aperture being where the abscess had been opened in the eighth intercostal space behind, and the other aperture in the iliocostal space in the site of the nephrotomy wound. The fistula persisted without interruption, and was attended by great debility and attacks of high fever up to the time of the operation in February, 1897.

Another and very important effect of this condensed contracted tissue filling the hilum and surrounding the whole of the kidney is that it shortens and stiffens the pedicle, and compresses and destroys the elasticity of the renal vessels and of the ureter. The result of this is that the kidney gets tucked close up against the spinal column, and becomes as firmly set in its surroundings as if it were embedded in plaster of Paris. If nephrotomy is done under these conditions the kidney cannot be brought well into, still less out of, the wound; and owing to the indurated incompressible tissue in which the pedicle is embedded the renal artery cannot be controlled when the renal parenchyma is incised and the kidney cavity explored, and thus bleeding is apt to be very free, possibly even dangerous. Still another effect is the risk of injuring the colon and peritoneum, owing to their adhesion to the inflamed and sclerosed perinephric tissue and to the difficulty there sometimes is in separating them in the process of clearing the posterior surface of the kidney. This makes the complete exploration in some cases very difficult or actually impossible without injury being done to the bowel or the membrane. Though a laceration of either viscus or peritoneum can be readily closed by suturing, it is a complication which takes time as well as gives trouble to repair.

Another difficulty consists in the frequent expansion of one of the calyces in the upper pole of the kidney, which spreads under the lower ribs, pushing up the liver or spleen and rendering a digital examination of the sacculus and the removal of a calculus therefrom a most difficult if not an impossible task, without excising the terminal inch or more of the twelfth, and perhaps also a portion of the eleventh rib. It is far quicker and safer to excise a piece of the last rib than to break up a stone which cannot be removed entire from such a cavity; for there is no security against leaving a portion of calculus behind in the recesses beyond the reach of the finger tip. In some cases the only thing to do to enable the surgeon to reach, to puncture, and evacuate the uppermost pouches of a greatly sacculated organ is to excise the last rib.

The excision of the rib or ribs is quickly effected by making a vertical incision upwards from the oblique incision in the iliocostal space, and then reflecting the flaps to the necessary degree.

The excision should be quite subperiosteal. The yielding of the soft tissues which immediately surround the ribs and which remain undivided, gives all the room required for reaching and examining and if requisite enucleating the upper end of the kidney. There need be no fear about wounding the pleura if the surgeon will begin the process of clearing the rib fairly upon its superficial aspect cutting immediately through its periosteum, keeping close to the bone itself, and stripping off the periosteum as he works round the deep aspect of the rib. I have removed a large portion of the last rib in many cases and, as mentioned above, have in one instance removed portions of the four lower ribs, and without injury to the pleura. Indeed, there is no more reason why the pleural cavity should be opened when excising the rib for renal operations than when operating for empyema in which it is the rule to leave the pleura intact until after the bones have been removed.

When perinephric suppuration is making its way to the surface of the loin, the redness and œdema of the skin and the evident pointing of the abscess may cause the parietal incision to be made at a point further back or further forward or higher or lower than the line of the best incision, and from this unusual incision it may not be convenient or easy to expose the kidney. But this is not of much consequence, because, as a rule, it is better practice not to search for and explore the kidney when the tissues surrounding it are in an acutely suppurating condition. The safer course is to defer the exploration till after the perinephric abscess has discharged and the tissues have returned to a quiescent state.

2. *The difficulties and danger which occur from conditions within the kidney* are even more serious than those in the structures around it.

In connection with the stone in calculous pyo-nephrosis there are several difficulties. One is the trouble in finding in a large sacculated organ a small stone which has slipped from beneath the finger, or which has perhaps been carried into the perinephric cellular tissue with the outward rush of the pent-up fluid contents on opening the kidney. This will be obviated by a wide external incision and by laying open as freely as possible the calyces and cavity of the kidney.

Other difficulties presented by the stone are the following. A large-branched calculus may be so lightly embraced by the kidney substance, and the kidney may be so uniformly even on its surface, that nothing more than a very firm tough organ may be thought to be present, and even on passing a needle into it no sense of calculus, but rather the resistance of a tough fibroma, is encountered. In these cases much difficulty will be experienced in freeing the stone from its encasement, and for this purpose the moderately free use of a bistoury will be required. It is astonishing how easily some of the large branches of a calculus may escape detection unless the surgeon is aware of the tenacity with which they are embraced by the tough renal parenchyma. With the finger within the cavity of the kidney nothing but renal tissue may be felt, yet, on scratching through this at points where the resistance is considerable, branch after branch of a large stone may be exposed, showing that more of a calculus would have been left behind than removed had the operation been concluded before all intercalycal septa had been perforated.

Sometimes in feeling over the kidney, a portion of it varying in size from a sixpence to a five-shilling piece, or larger, is found soft, flaccid, thin, or fluctuating, but there is nowhere any sense of hardness or increased resistance, such as might be expected from even a soft phosphatic stone. On incising this soft area, pus or purulent urine is let out, but no stone is found; yet, on introducing the finger into the interior of such a kidney, a small calculus may be detected, freely movable within an enlarged pelvis, or fixed in a dilated calyx, or possibly at the apex of a funnel-shaped pelvis. Such cases show that aspiration, or simple incision and drainage are insufficient, and that the surgeon ought not to be satisfied with anything less than a thorough digital exploration of the interior of the renal pelvis, the calyces, and the orifice of the ureter.

Another condition of calculus is sometimes found in sacculated kidneys. The renal cavity may be partially or wholly filled with a soft, mortary phosphatic concretion, which gives no sound or resistance to the scalpel or trocar, and yet, on incising the renal substance and inserting the finger a calculous mass of considerable size may be felt.

In other cases again some hundreds of small circular calculi, like millet seeds, may be scattered in little groups throughout the organ, and found occupying small abscess cavities or ulcerated spaces in the parenchyma as well as the calyces. These calculi may be too numerous and scattered to be all removed, and the question may require to be decided whether nephrectomy should be performed or not. Nephrectomy in such cases is a dangerous procedure, for it is highly probable that the opposite kidney is also more or less destroyed by calculus. I reported a case of this kind in which fortunately I did not remove the kidney; nevertheless, the patient afterwards died of anuria.*

Hæmorrhage.—The most formidable and dangerous complication of nephrotomy is hæmorrhage. Hæmorrhage is apt to occur in the very cases of calculous nephrectasis or traumatic nephrectasis in which it is most difficult to control the bleeding without resorting to nephrectomy, and yet most dangerous to life to perform this operation.

In the cases of calculous hæmato-nephrosis to which I now refer there is a large, very hard, solid tumour, which pretty certainly has been regarded as a malignant new growth—at least, this was so in the three cases upon which I have operated. Probably there is a long calculus history without noticeable renal tumour; then there is discovered a tumour in the lumbar region, which rapidly increases, and causes pain and discomfort on movement, gastro-intestinal disturbance, pressure ill effects, and rapid impairment of health. The diagnosis is sooner or later made of malignant disease, perhaps of the liver or spleen, perhaps of the kidney, perhaps of the cæcum or ascending or descending colon, according to the side. If the kidney is cut down upon from the loin all the tissues are found densely sclerosed, toughly adherent. With difficulty the perinephric fibro-fatty tissue is cleared sufficiently to expose a small area of the posterior surface of the kidney. The kidney is incised, and a quantity of old discoloured chocolate-brown, and also perhaps some recent blood-clot, together with a large branched calculus, are laid bare. More or less of the blood-clot is turned out, and, with the object of removing the calculus, the incision in the kidney is enlarged, and the tough fibrous septa dividing up the renal cavity and bridling down the processes of the calculus are divided. Then the hæmorrhage ensues, the blood coming perhaps from the same source as the blood which has coagulated within the kidney prior to the operation, perhaps from the very vascular tough septa which have been torn or divided in the attempt to extract the calculus. Plugging the cavity, injection of hot water, pressure on the exterior of the kidney, compression of the renal artery through the abdominal walls or with the hand in the wound, are attempted and fail to stay the bleeding. Finally, as a last resource, the difficult task of enucleating the kidney from the surrounding tough mass of fibro-lipomatous substance is undertaken, and the surgeon may congratulate himself if he succeeds in getting his patient safely off the operating table.

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* *Clin. Trans.*, vol. xx., p. 106 (1887).

In one of my cases, in spite of restoratives and saline infusion, I barely succeeded in doing this. In a second case the patient died the following day, death being due to shock aggravated by the vomiting which followed the operation. The vomiting may have been largely or entirely due to the anæsthetic, but I could not help thinking that the disturbance of the sympathetic ganglia and nerves, necessitated by the separation and removal of so large and firmly adherent a mass, had much to do with it.

A case of old-standing traumatic renal aneurysm upon which I operated (*see Lancet,* October 6, 1900) was even more formidable. It was, indeed, the most formidable and desperate operation I have ever had to perform, and short of actually tearing open the vena cava or aorta (neither of which accidents, I am thankful to say, has ever happened to me), I cannot imagine anything more terrible to encounter in an operation than the pumping rush of blood which followed the removal of a couple of handfuls—only a very small portion of the entire quantity—of discoloured and partially laminated blood-clot from the false aneurysmal cavity.

My conviction is that in such cases, as soon as the kidney has been cut into and the large tumour which it forms is found to be composed largely or entirely of blood-clot—whether there be a calculus present or not—the proper course at once to adopt is to desist from further disturbance of the clot or calculus for the moment, to turn the patient on to his back, and open the abdomen in the median line, or along the linea semilunaris on the same side as the tumour, and then to get a reliable assistant to control the aorta by digital compression whilst the renal cavity is being emptied, the renal pedicle reached either through the interior of the renal pelvis or after separating the circumrenal tissue, and the renal artery ligatured. Theoretically, it would no doubt be best to ligature at once the renal artery across the peritoneal cavity instead of having the aorta compressed by an assistant, and this in some cases doubtless could be done; but in two of my cases—one a case of enormous calculous hæmato-nephrosis, and the other of traumatic hæmato-nephrosis, and more especially the latter—the renal pedicle and the large trunk vessels in front of the spinal column were too much covered by the solid fixed tumour for this to have been feasible.

The source of the hæmorrhage into the renal cavity may be a large branch of the renal artery which has been laid open by ulceration caused by the irritation and pressure of a spiked calculus impacted in the renal pelvis or embedded in a calyx. Hæmorrhage from such a source may take place either before or after nephrotomy. Death from this cause occurred on the seventh day after the operation in a case in which several calculi were removed from a hydro-nephrotic kidney.* After death the kidney was found enormously distended with blood-clot and bloody urine, owing to a calculus which had been overlooked and which was embedded in the renal substance having ulcerated into a branch of the renal artery.

Jacobson records a case of death from hæmorrhage seventeen hours after nephrotomy from, as he suggests, "marked contraction of the mitral valve." The patient was a man aged thirty-five, from whom two calculi, weighing ninety-four grains, were removed. There was serious bleeding at the time of the operation, which was controlled by pressure; hæmorrhage with collapse occurred three hours after the operation and recurred four hours later. Nothing was found in the wound at the autopsy to explain the loss of blood. Jacobson points out that parturient women with contracted mitral valve are especially liable to the peril of flooding.

In a case of hæmato-nephrosis in a man upon whom I performed nephrotomy, a quantity of black clot was turned out of the kidney, but no definite source of hæmorrhage was found. He was greatly relieved of pain, but died over a year after the nephrotomy; at the post-mortem the kidney was found to have become shrivelled into a very small organ the size of a fig, and a sarcomatous growth was discovered in the spinal column near by.

But in spite of what has been pointed out in the foregoing remarks, nephrotomy in the great majority of cases is far from dangerous. Its mortality, taking all kinds of cases for which it is performed, was 22·6 per cent. in 259 cases (Tuffier). It is more fatal in cases of a septic nature, such as calculous and traumatic pyelitis and pyo-nephrosis and abscess, than in simple hydro-nephrosis and simple and hydatid cysts. It is most fatal in pyelo-nephritis, the number being 47·8 per cent. (Tuffier).

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* W. E. Steavenson M.D., and A. C. Butler-Smythe: *Clin. Trans.*, vol. xxii., p. 214.

Many of the patients who survive are inconvenienced by a more or less permanent fistula, and this is more likely to follow nephrotomy for hydro-nephrosis than when performed for some septic conditions such as calculous pyelitis and pyo-nephrosis and small circumscribed renal abscess. The purulent fistulæ, often spontaneous, close after persisting for many months or a year or two. I have known several to do so; others remain until cured by excision of the fistulous track, or by nephrectomy. Urinous fistula following nephrotomy for hydro-nephrosis with permanent ureteral obstruction, may never attempt to close. One of my patients has had his fistula uninterruptedly discharging for over sixteen years; he wears a urinal at the loin, into which nearly as much urine is discharged as he passes through the bladder; he is active, and in the best of health, and always declines the proposal of having an operation performed to cure the fistula.

Some fistulæ—urino-purulent for the most part—cause occasional trouble by superficially closing, the fistulous track becoming distended and inflamed until an abscess breaks or is opened at the old fistulous site or elsewhere.

The dangers of nephrotomy are not in the operation itself, but depend almost entirely upon the condition of kidney for which the opening is made. The operation itself is in most cases very simple. When done for cystic tumours the probability is that with a free drain for its contents the cavity will soon contract, and the wound close by granulations; when done for hydro-nephrosis or pyo-nephrosis set up by some permanent obstruction in the ureter, a continuous and persistent flow of urine, or pus mixed with urine, must ensue; and unless this fistula is cured by nephrectomy a receptacle into which the fluid can trickle and be retained should be adjusted to the loin and constantly worn. Such an instrument was made for my patients years ago by Hawksley and by Maw, Son, and Thompson.

When nephrotomy is performed for traumatic or calculous abscess, complete recovery will probably take place; but if the kidney is entirely converted into an abscess sac, or is the seat of breaking-down scrofulous deposit, the patient though benefited for a time may be worn out at length by suppuration or septic fever. It would be far better in such cases to perform nephrectomy.

NEPHROTRESIS.

Nephrotresis is the term applied to the operation whereby a renal urinary fistula is deliberately established by a surgical operation. In my original treatise on the "Surgical Diseases of the Kidney," published early in 1885, I included this operation under nephrotomy; but since that date there has very properly been made a distinction in nomenclature for those operations which are destined to perpetuate an opening in a viscus, from those in which the same viscus is simply cut into and the opening is afterwards encouraged, or allowed, to close, *e.g.* gastrostomy—gastrotomy, enterostomy—enterotomy; and the same distinction seems to be desirable in the case of the kidney, and has been made by foreign authors by using the term nephrostomy.

Nephrotresis, which I propose as a substitute for the unsuitable name nephrostomy, is indicated under certain conditions in three very different classes of cases: (1) to relieve suppression and retention of urine from obstructive causes situated in the ureter; (2) to relieve renal retention and to provide a direct external outlet for the urine in cases of nephrectasis—whether aseptic or septic—in which an irremovable obstruction prevents the urine passing by the natural channel; and (3) to divert the urine in certain cases of fistula or discharge of urine into some unnatural cavity or part.

In the first group are included cases of anuria from calculus impacted in the ureter; from ureteral obstruction from pressure by tumours, abdominal or pelvic; from pelvic cellulitis or from cancerous infiltration of the peri-uterine tissues.

In the second group the conditions for which it has been performed are hydro-nephrosis and pyo-nephrosis, when the cause of the renal dilatation persists and is not capable of being removed, or the patient is unwilling to submit to the risk of the operation necessary for its removal.

In the third group may be included those cases of loss of substance of the ureter, and of other injuries to the ureter, which occur occasionally during the progress of surgical operations, whereby the channel to the bladder is interrupted and the condition of the injured duct does not allow of grafting its proximal end into the bladder (uretero-cysto-neostomy). For these injuries, however, lumbar ureterotresis will take the place of nephrotresis. It has in one case been performed by R.

Harrison for the relief of the miserable plight caused by ectopia vesicæ, after the opposite kidney had been removed. This case, after doing well for a time, and as long as the patient was under surgical supervision, ended unfavourably through suppurative pyelo-nephritis. Septic infection is a serious risk attending, equally, every case of nephrotresis and cutaneous ureterotresis.

Nephrotresis has been performed both by the *trans-peritoneal* and the *lumbar methods*. To the lumbar method the preference must be given in all but exceptional circumstances. The reasons for this choice are the much greater freedom from risk if the peritoneum is not exposed to contamination from the renal contents; and the greater facility for closing the fistula by some future surgical treatment when the continuance of the lumbar exit for urine is no longer needed.

In anuria the kidney, although possibly engorged and thereby enlarged, will almost certainly be occupying its normal place against the vertebral column, and therefore it would be difficult to establish good drainage across the peritoneal cavity. Many of the persons who are the subjects of obstructive anuria and of the calculous form especially are very stout, and in them drainage would be impossible by the trans-peritoneal route.

In pyo-nephrosis the trans-peritoneal operation exposes the patient to the risk of peritoneal infection; and if the pyo-nephrotic tumour has subsequently to be removed, nephrectomy presents serious risks after the kidney has been thus fixed to the anterior wall of the abdomen.

It is only in cases of hydro-nephrosis with great dilatation, and in cases of nephrectasis of a kidney misplaced into the pelvis, that abdominal or trans-peritoneal nephrotresis is justifiable. Even in the case of an enormous hydro-nephrotic sac, any subsequent operation undertaken for the cure of the cause of the obstruction will be much easier and freer of risk if the fistulous opening is in the loin instead of on the front of the abdomen.

Should a permanent fistula be required in a case of misplaced kidney I should prefer to perform an anterior extra-peritoneal operation and transplant the proximal portion of the ureter into the loin if the portion of that tube above the obstruction were long enough to permit of this.

The lumbar operation.—The incision and the other steps of the operation to expose the kidney are the same as in nephrotomy and lumbar nephrolithotomy. If the operation is commenced with the intention of simply establishing a fistula, and not of making an exploratory nephrotomy first, it will not be necessary to enucleate the kidney, unless the establishment of a more satisfactory opening on the surface of the loin can be better effected by bringing the kidney into the wound in the parietes. Otherwise it is sufficient to clear a portion of the posterior surface of the kidney or the renal pelvis, and into the one or the other (as the intention of the surgeon may be) an incision is made with bistoury or scissors to the extent required to enable the finger to enter and explore the renal cavity. The divided edges of the kidney or renal pelvis are then to be sutured to the cut edges of the skin or the parietal muscles.

When the kidney is not dilated.—In obstructive anuria, especially when the obstruction is caused by a calculus suddenly impacted in the ureter, the kidney is most likely hypertrophied and much congested but the renal pelvis will in all probability not be dilated. The incision into the kidney should then be along the convex border just as when made for the ordinary exploration for stone. The cut edges of the kidney will bleed freely at first, will gape widely, and either a little urine only, or possibly several ounces, will escape at once from the now opened-up pelvis and calyces. After staying the bleeding in the manner described on p. 138 (Vol. II.), one or more sutures should be inserted to fix the cut renal edges to the edges of the parietal wound; to the deep layers of the divided tissues, if the prospect is that a fistulous opening will not be required long; to the skin if it is expected that the fistula will have to be permanent. The lumbar wound should be closed in the usual manner, except where the edges of the wound in the kidney are fixed up to the edges of the wound in the loin. Tuffier has watched for ten months patients upon whom he has operated for obstructive anuria due to compression of the ureter by cancer. In one case of this sort he transplanted the ureter which was obstructed by uterine cancer into another part of the bladder. A much more satisfactory result is of course obtained from uretero-vesical grafting, whereby the abominable infirmity of a permanent lumbar fistula is avoided.

When the kidney is dilated.—In nephrotresis for nephrectasis—aseptic or septic—the posterior surface of the kidney should be palpated in search of any spot where the parenchyma is softer and thinner than elsewhere, and here the incision should be made into the renal cavity. The septa between the pouches should be broken down with the index finger, or divided with a blunt probe-pointed bistoury, and several pouches should be made to communicate with one another and with the renal pelvis so as to form but a single cavity. By palpation it should be ascertained that all the sacculi have been opened, and their contents evacuated. It is well also to ascertain if the pelvo-ureteral orifice and the ureter itself are patent, by trying to make a bougie or sound enter it.

Abdominal or trans-peritoneal nephrotresis. — When a hydro-nephrotic kidney is so far dilated as to form a large abdominal tumour which is in more or less extensive contact with the front and lateral abdominal parietes, it is easy to establish a fistula of the kidney in the front or antero-lateral aspect of the abdomen.

Albarran speaks of having performed the trans-peritoneal operation for pyo-nephrosis (1) when pyo-nephrosis was developed in a kidney which was freely movable and when secondary adhesions had fixed the kidney against the abdominal wall and far away from the lumbar fossa; (2) in a case of pyo-nephrosis when the kidney was misplaced in the pelvis.

It may possibly be that in such very exceptional cases as these the lumbar operation is very difficult or even impossible; but the trans-peritoneal operation is very inferior to the lumbar in all ordinary cases.

When nephrotresis is practised across the abdomen for pyo-nephrosis, special and minute precautions ought to be taken to prevent contamination of the peritoneum with the contents of the urinary cavity.

The abdomen is opened in the middle line, or in the linea semilunaris on the side of the affected organ. The intestines are then crowded aside and retained behind sterilised sponges placed in the abdomen. The peritoneum covering the tumour should then be divided and detached for one or two inches on each side of the incision, and the cut edges should be sutured to the parietal peritoneum. In this way the general peritoneal cavity is completely shut off before cutting into the kidney itself. Finally the cut edges of the renal tissue are sutured to the cut edges of the abdominal parietes.

CHAPTER XXX.

OPERATIONS ON THE KIDNEY AND THE METHODS OF PERFORMING THEM (*Continued*).

NEPHRORRAPHY OR NEPHROPEXY.

IN April, 1881—fourteen months after the first nephrolithotomy—Hahn of Berlin introduced an operation for fixing movable kidneys which he called nephrorraphy, but which was named afterwards by Le Dentu nephropexy (following the appellation given by Trélat to the operation for fixing the uterus, hysteropexy). Hahn's operation consisted in an incision alongside the sacro-lumbalis muscle (such as the old writers advised for nephrotomy and Simon had employed for nephrectomy) extending from the twelfth rib to the crest of the ilium. The quadratus lumborum was cut; and the fibro-fatty capsule was opened along the outer border of the kidney, and having been separated to some extent was dragged forcibly backwards into the wound along with the kidney. By means of six or eight catgut sutures this capsule was stitched into the wound, and the wound itself plugged with carbolic gauze.

In his account, published in July, 1881, Hahn describes two cases thus operated upon by himself in April of that year. The patients were both women, and they recovered in four weeks with the kidneys as securely in their attached position as immediately after the operation.

This was an important advance, because it at once had the effect of putting a stop to nephrectomy for movable kidney which had been recommended and practised by Martin of Berlin in 1878. The importance of this step was indeed great, for it not only brought about the substitution of a safe operation for one which, at that time especially, was attended with a very high mortality, but it also saved healthy organs from being needlessly excised, and was applicable to both kidneys of the same person when both were movable and required fixing.

The principle of Hahn's operation was perfect, but the results were unsatisfactory; what was wanted was the improvement of the technique. The consequence was that a very large number of modifications and variations were proposed and practised in that part of the operation immediately concerned with the mode of fixing the kidney to the lumbar parietes. An account of these will be attempted farther on.

Indications for the operation.—Nephropexy is practised in cases of floating, movable, or wandering kidney, when the organ is the seat of frequent, severe, and spasmodic attacks of pain, or of more or less continuous suffering. Its object is to fix the kidney by exposing it through an incision in the loin, such as that described for nephrotomy or nephrolithotomy. This done, silk or other sutures are passed into or through the renal parenchyma, or through the detached renal capsule and the edges of the parietal wound. By tightening and knotting the sutures the kidney is fixed back against the lumbar parietes.

There is no denying the fact, which has been often and unfairly charged against the operation in every form and for every kind of case, that it is not always successful, and has not always remained permanently efficacious even in cases in which it was so for a time after the operation.

This is owing to two very different causes: (1) The improper selection of cases, and (2) the imperfection of the methods of operation which have often been employed for fixing the kidney.

The first point, the selection of cases suitable for operation and likely to be benefited by it, and the cases in which either the operation is not indicated or in which it ought to be performed with a very guarded prognosis as to the result on the symptoms, has been discussed in the chapter on Movable Kidney (Vol. I.).

As to the second point, the opinions and practice of different surgeons are still greatly at variance. That such differences exist shows either that there are several methods pretty equally successful or that no one method has such distinct or superlative advantage over the others as to have universally or even widely commended itself in preference to the rest.

In one particular, however, all operators are now agreed, namely, that the original plan of Hahn, and every modification of it whereby only the perinephric tissue—the fibro-fatty investment of the kidney—is shortened and fastened to the parietes, is useless or at any rate uncertain and therefore unsatisfactory.

Probably in one other particular all or most surgeons whose experience is large enough to give weight to their opinions would agree, namely that permanent not temporary sutures are requisite, by which I mean sutures which will remain buried in the tissues and are not removed at the end of ten, twelve, or fifteen days.

The operation.—The different methods of fixing the kidney now in vogue may be divided into two chief classes:—

A. Those in which the partial decortication or stripping off of the capsule of the kidney forms part of the process.

B. Those in which no decortication is practised.

In the first class the sutures (*a*) transfix the parenchyma of the kidney (Tuffier; Jonnesco; and in a very modified way the principle of decortication is acted upon in Bruce Clarke's method); or (*b*) penetrate only the deflected flaps of the capsule (Newman, Jacobson, Lane, Law, Edebohls).

In the second class the sutures are employed in three different ways: (*a*) They simply under-run the middle three-quarters of the capsule on the posterior aspect of the kidney (Vulliet); (*b*) they are made to transfix the whole thickness of the kidney (Albarran); (*c*) they are made to pass in a curvilinear manner through only part of the thickness of the parenchyma (author's method).

In addition to the differences in practice with reference to the insertion of the sutures into the kidney, there are differences with reference to their attachment to the parietes; some surgeons fixing the upper sutures to the last rib, others fixing all into the deeper layers, and others again, to the more superficial structures of the loin.

A. **The methods of decortication.**—Tuffier,* believing that the proper capsule of the kidney—smooth, thin, little resisting, non-vascular, and fibrous as it is—prevents the kidney itself from forming firm adhesions with the tissues and organs around it, recommends its partial decortication, and the suturing of the tunica propria to the edges of the parietal wound. This done, he thinks the parenchyma does not fail to attach itself firmly to the neighbouring tissues by the whole of the exposed area. The cicatrix which is obtained is so strong that the kidney ruptures before the adhesions give way. Various modifications of Tuffier's method have been practised by different surgeons, but the principle of them all is to obtain direct adhesion between the bared parenchyma and the deep tissues of the abdominal wall; whether the capsule is detached in small squares, or in one large piece, or in many triangular slips.

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* "Études Expérimentales sur la Chirurgie du Rein," 1889, pp. 57–63.

The following is the method described by him in his latest writings:—*

The method of Tuffier.—A slightly oblique or nearly vertical incision is made from the eleventh rib to the crest of the ilium, four finger breadths from the spines of the lumbar vertebræ. The kidney having been pressed backwards and fixed by an assistant, its fatty capsule is carefully opened and separated from the surface of the organ. When thus denuded in all the extent of its convex border and its two adjacent surfaces, a thick catgut suture is passed through the parenchyma, at the lower part of the organ, in such a way as to fix it and draw it between the separated lips of the wound. In the same way a second suture is passed about four centimetres below the upper end of the organ; then, upon the posterior surface and convex border, the proper capsule of the kidney is dissected off so as to freshen the cortical parenchyma. The slight bleeding which follows this dissection is arrested by compression. A third suture is then passed through the middle of the renal substance. These three sutures are passed with a curved needle, and are either single or double. The substances employed are catgut or the tendons of kangaroo, which are absorbed less quickly. The sutures are fixed, the superior to the periosteum of the outer surface of the twelfth rib, the middle and inferior to the deep aponeurosis in the wound; they are tightened moderately, so as not to cut through the parenchyma, but so as to bring into apposition the freshened surface of the kidney and the lumbar wall. The kidney so fixed is below its normal situation,—to which it is impossible to attach it without perforating the diaphragm. The different muscular layers are sutured in three stages with catgut, and the skin is united with silkworm gut. No drainage is employed.

Twenty days is the period prescribed for the patient to remain upon her back, during which she should keep as immovable as possible, with the pelvis raised upon a pillow.

The method of Jacobson.—Jacobson considers the method of passing sutures through the tissue of the kidney itself quite unreliable. He believes that, owing to the well-known friability of the kidney, and the increased softness of it when injured and inflamed, as around a suture, even when silk sutures are passed and left *in situ* their cutting through is only a matter of time. When catgut, however stout, has been employed the result is still worse. Like silk, it is very liable on being tied to cut its way through the kidney tissue; and if it does not do so, the tendency for it to become rapidly softened and absorbed, more especially within the substance of the kidney, renders it impossible to form a permanent anchorage with this material. "Moreover, there is another danger, not altogether a fanciful one, which may follow on deeply puncturing the kidney. A German surgeon (Barth) has seen a necrotic centre caused in the kidney owing to the occlusion of one of the arterial centres by the anchoring suture. A similar condition has been noted as the result of puncture." Jacobson suggests further that in delicate patients the injury inflicted by suturing might be the starting point of tuberculous disease of the kidney. Sterilised silk, not of the plaited kind, is the material which he recommends for the sutures. Kangaroo-tail tendon he regards as another excellent material. The sutures should take hold of the proper capsule of the kidney, after this has been carefully peeled off in two flaps.

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* "Traité de Chirurgie" Duplay and Reclus, 2nd ed., 1899, tome vii.

The organ is exposed by an incision such as he recommends in nephrolithotomy, parallel with the last rib and half an inch below it, four inches in length, and beginning about two and a half inches from the spine.

"The kidney having been exposed, it is gently withdrawn through the wound, surrounded by aseptic sponges, while an incision is made with a very light hand all along the convex border from end to end. Unless the utmost gentleness is taken in the last step the tissue of the organ itself will certainly be incised, causing free oozing. With the handle of a scalpel or a blunt dissector a flap of capsule is then deliberately but gently stripped off the kidney up to a point about half-way along its lateral surfaces, so as to raise a sufficient flap for the sutures to find a holding in. The flaps having been raised, they are sutured with medium-sized sterilised silk to the aponeurotic and subcutaneous edges of the wound. To get a firm and permanent holding each suture should take up plenty of capsule on the one side and a sufficient grip of the lumbar fascia on the other. I generally use upwards of twenty sutures, perhaps twelve in one flap and eight in the other. One word of caution should be added. This method of anchoring is so efficient that unless care is taken it is possible to fix the kidney actually in, and not beneath, the lips of the wound."

Any oozing met with after deflecting the flaps of capsule yields to sponge pressure. The wound is very carefully dried out after all bleeding is arrested, and dusted with Jeyes' powder. No drainage tube will be required.

In closing the wound buried sutures of chromic gut, and for the skin sutures of salmon gut are used. Jacobson concludes by saying: "So convinced am I of the superiority of this method that I shall not occupy my space . . . in describing any other."

Arbuthnot Lane has practised a modification of the manner of stripping off the capsule by which he anchors the kidney. Freely exposing the kidney and removing all the fat, fascia, and areolar tissue which intervene between the kidney and the muscular wall of the abdomen, he makes a considerable number of incisions through the capsule covering the posterior surface of the kidney, radiating from its centre, so that this portion of the capsule is subdivided into ten triangles, the bases of which correspond to the margin of the kidney. These are stripped off the organ and left attached to it by their bases only. Each of these triangular processes of capsule is twisted so as to prevent it from tearing, and to each a silk ligature is attached. This forms a secure attachment, and much strain could be exerted on each ligature without the section of capsule to which it is attached showing any signs of yielding.

"At regular intervals, corresponding to the attachments of the segments of the capsule, small incisions were made through the transversalis muscles and superjacent structures, and through each a ligature with the attached portion of capsule was drawn. The adjoining ligatures were then tied firmly together. By these means the posterior surface of the kidney, bared of its capsule, was retained immovably in firm, accurate, and immediate contact with the transversalis aponeurosis and muscle, and the cut margin of the more superficial muscles by the several anchoring processes of the capsule."

Newman † of Glasgow makes a vertical parietal incision and splits the fibrous capsule by incising it along the outer border of the kidney. He then strips off the capsule for a third of an inch all around the incision, and sutures it to the parietes. A large rubber drainage tube is inserted between the deeper parts of the wound and the surface of the kidney in order to promote adhesions. A wedge-shaped mass of granulation

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* *Clin. Trans.*, vol. xxv., p. 203.

† Newman's "Surgical Studies: Renal Cases."

tissue forms, the apex corresponding to the cutaneous surface, while the base lies against the raw surface of the kidney. Newman adds: "In all the cases in which I have operated the result has been most satisfactory."

*Jonnesco's method.**—Out of twelve cases, the perpendicular incision was practised in the first three operations, in the other nine the oblique incision. He preferred the oblique, as it facilitates the fastening of the kidney to the ribs.

When the kidney was exposed the fatty and fibrous capsules were stripped off along the whole length of its outer side. The capsule was detached for about half a centimetre.

The stitches are passed through the skin three cm. from the inner edges of the wound, through the sacro-lumbalis and the deep aponeurosis. The first traverses the fibrous capsule on the hinder surface of the kidney near its upper end, through the kidney parenchyma one and a half cm. from the outer side of the organ, through the capsule and through the periosteum of the twelfth or eleventh rib, according to the size of the incision; then through all the layers three cm. from the outer edge of the wound.

Two other sutures are similarly passed, one in the middle and one at the lower end of the kidney. All these three sutures go through the periosteum of the twelfth or eleventh ribs respectively.

These sutures were drawn only tight enough to suspend the kidney, care being taken, as far as possible, to avoid cutting the parenchyma.

The edges of the wound were then closed with sutures. On the tenth day the sutures were taken out. In later cases Jonnesco avoided silk in favour of "crin de Florence" (one case) and silver wire (two cases). The object of wire was to lessen the danger of cutting through the kidney substance. The wires were removed on the tenth day. By the use of silver wire complete asepsis was obtained, and the tearing of the kidney avoided.

The method of passing the stitches through the capsule has the advantage of preventing them from cutting the parenchyma. By the drawing out of the stitches after a fixed time, when cicatrisation is firm, all necessity for permanent sutures is avoided, as is also the formation of a fistula and the occurrence of pain. There is also a minimum amount of induration near the sutures.

Experiments of this method on dogs showed hard sclerotic tissue on the surface of the decorticated portion, which only occupied the upper layer of the cortical surface, and there were only slight changes round the sites of the sutures; thus the sclerotic tissue, by this method, is reduced to a minimum.

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* *Centralblatt für Chirurgie*, No. 30, 1897.

Experiments on dogs showed that firm cicatricial tissue is formed by the seventeenth day, so that the kidney was firmly adherent to the ribs.

As a result of experiments, Jonnesco thinks that a firm adhesion would be formed in ten days in man, but in order to strengthen it the patient should remain in bed twenty days.

He claims the following advantages for his method: (1) Simplicity; (2) firm fixation of kidney; (3) avoidance of after-effects (such as pain, fistula, suppuration, and excessive formation of sclerotic tissue in the parenchyma of kidney) by withdrawal of stitches.

Bruce Clarke's[*] *plan* is "to cut down and remove the perinephric fat on the back surface of the kidney, after which he passes a long curved needle with carefully sterilised silk ligatures through the lumbar fascia and through the kidney, not too deeply, but embracing a sufficient amount of kidney tissue, scraping the surface of the kidney before drawing the ligatures. He then closes the wound in the ordinary way. He invariably leaves in a drainage tube, in order to provide for an escape of urine from the incision into the kidney substance, which he always makes for the purposes of exploration."

B. **Methods without decortication.**—Under this class come the operations of Hahn (his second method), of Bassini, of Ceccherelli, of Paoli, and of Duret of Lille.[†] These will be described very briefly because they are unnecessarily complex, and are not, so far as I can learn, practised at the present time, at any rate by surgeons either in France or in this country. Other methods without decortication have been employed by Gardner, Vulliet, Albarran, and myself.

Hahn himself, finding his first method did not succeed, suggested passing the sutures through the fibrous *proper capsule* of the kidney.

Bassini[‡] in 1882 employed sutures passed through the fatty capsule and the *proper fibrous capsule*. He passed one suture at the level of the middle part of the convex border, a second on the posterior surface, and a third on the anterior surface, and fixed all three to corresponding parts of the deep tissues of the wound. Then he divided transversely the fatty tissue covering the lower half of the kidney into four portions, of which he fixed one to the periosteum of the eleventh rib, the second to the anterior lip of the wound, the third and fourth, corresponding to the inferior pole of the kidney, to the posterior lip.

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[*] *Trans. Med. Soc.* for 1885, vol. xviii., p. 288.

[†] Duret, "Du Traitement des Reins Mobiles par la Nephrorraphie," *Bulletin de l'Acad. Roy. de Belgique*, 1888. Vanneufville, "De la Nephrorraphie, Étude Clinique et Expérimentale," Th. de Doct., Paris, 1888.

[‡] Bassini, *Ann. Univ. di Med. e di Chir.*, Sept. 1882.

Ceccherelli two years later performed an operation which differed from Bassini's in the introduction of the sutures into the cortical substance of the kidney; four catgut sutures thus passed into the kidney were tied round the twelfth rib, and three passed into the kidney near its lower end were fixed to the deep parts of the parietal wound. The cellulo-fatty capsule was taken up in these sutures.

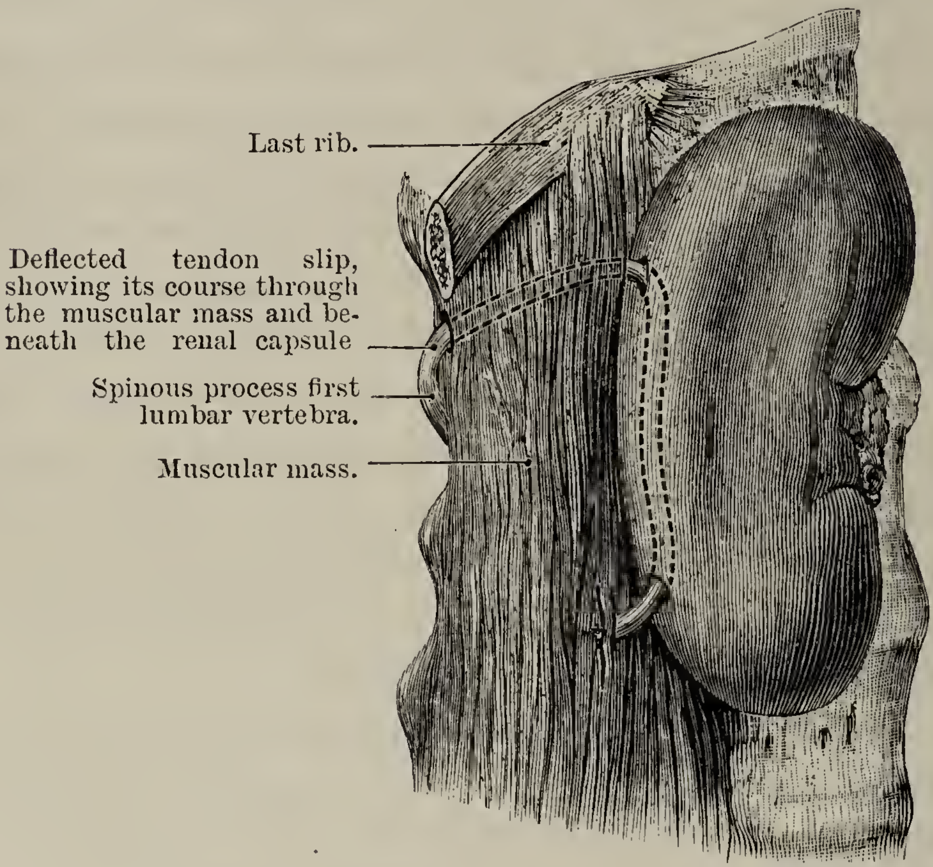
Last rib.
Deflected tendon slip, showing its course through the muscular mass and beneath the renal capsule
Spinous process first lumbar vertebra.
Muscular mass.

Fig. 128.—Vulliet's method of fixing Kidney. A side view, showing the spinous processes of the lumbar vertebræ as well as the side of the bodies of those bones. The kidney is *in situ*, but the suture is made to appear to enter on the anterior instead of the posterior face. (Diagrammatic, copied from Vulliet's paper.)

Paoli and Duret excised part of the twelfth rib, and sutured the proper capsule of the kidney to the parts around; Duret fixed it by some of his sutures to the remainder of the twelfth rib.

W. Gardner of Melbourne[*] through an oblique incision in the loin opened the fibro-fatty capsule and put in two steadying stitches, which he passed through the sides of the incision. Finally,

[*] *Australian Medical Journal*, 1885, p. 145.

he passed two chromicised kangaroo tendons through the substance of the kidney, and about two inches apart; the ends of these tendons he passed through the edges of the parietal incision on each side, and tied them tightly, after inserting a drainage tube in the lower angle of the wound. The final result of this operation Gardner described as "excellent," the kidney not undergoing "the slightest change of position during the movements of the patient."

The method of Vulliet.—A method has recently been suggested by M. Vulliet* of Geneva—and was first tried by his friend Poullet of Lyons—of making a long slender slip of the tendon of the erector spinæ of the patient the means of fixation of the kidney. After exposing and freeing the kidney in the usual manner, a separate short vertical incision, parallel with the spinous process of the first lumbar vertebra, is made through skin and fascia, and a tape-like slip of the tendon about ten inches long and a quarter of an inch wide is detached and pulled out through this little wound, but still left attached by its lower end to the muscle. This tendinous slip is to be the suture, and is passed by means of a long, straight blunt needle in a handle, and with a large eye near the extremity, through the muscular tissue intervening between the one wound and the other down to the capsule of the kidney, and having been made to underrun the fibrous capsule of the kidney upon its posterior surface, and near the external border, it is then passed back again and fixed to the erector spinæ muscle by means of a suture of fine silk. This is shown in the accompanying figure.

In some instances in which I have employed this method I have found it requisite to modify Vulliet's procedure. If too short a length of the tendon tears out, I have split the width of the tendon and passed each portion separately through the intervening muscle mass down to the kidney. Having underrun the kidney capsule with one length of the tendon, the two lengths of tendon are tightly tied together. The kidney is thus slung into close contact with the lumbar fascia. The split end of the tendon which does not underrun the renal capsule can then, if desired, be passed back through the muscles and fixed in the erector spinæ mass, or the tendon unsplit may be lengthened by attaching a piece of ligature silk to its extremity, and after underrunning the renal capsule and returning the ligature and the tendon end to the erector spinæ, fixing the end of the tendon after cutting away the silk ligature.

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* Vulliet, "D'une Nouvelle Opération de Nephropexie," *Revue Médicale de la Suisse Romande*, 20 Juin, 1895, p. 326 *et seq.*

The method of Albarran. — Although Albarran does not actually state the line of his lumbar incision, the inference is that he employs the vertical one adopted by Hahn. He attaches great importance to the separation and the removal of the fatty tissue which covers the posterior surface of the kidney, with the view that the kidney denuded of all tissue except its fibrous capsule should be applied directly upon the anterior surface of the quadratus lumborum muscle. The detachment and removal of the circumrenal fat is best effected by the fingers, cutting instruments being apt to open vessels and necessitate the application of ligatures; and at the anterior part of the wound risk is run, unless great care be used, of opening the peritoneal cavity, or even of cutting the wall of the colon. All the exuberant part of the perinephric fat is removed after the kidney has been brought out through the lumbar wound.

When the surface of the kidney has been thus exposed three sutures of thick catgut (No. 5) are passed through the renal parenchyma by means of a large curved needle. Each suture traverses the external border of the kidney from the anterior to the posterior surface, and should be situated at a depth a good centimetre from the external border. The highest suture traverses the kidney at the junction of the upper third with the lower two-thirds; the lowest suture passes through the parenchyma at the junction of the upper three-fourths with the lower fourth; the middle suture corresponds to the middle part of the kidney.

Each suture consists of a double thread. The object of this is to avoid cutting through the renal parenchyma when tightening the suture by the ingenious manœuvre originated by Guyon. At the point of entrance and of exit of each double thread of catgut a double knot is made, and each end right and left of the loop is held with pressure forceps. So that when one comes to tighten the threads of catgut around the rib or across the muscular edges of the lumbar wound, pressure will be exercised not upon the renal parenchyma, but upon the knot at the point of entrance and exit of the loop of catgut.

When the three double threads of catgut have been thus placed through the kidney after it has been drawn up to the level of the incision, the kidney must be put into good position and fixed there. The two anterior ends of the upper suture are tied round the twelfth rib, and the posterior extremities of the same suture are similarly fixed to this rib. This is done by passing a curved needle in a handle with the eye near the point from above downwards close to the deep surface of the last rib; one of the posterior ends of the upper suture is threaded in the needle, and the needle then withdrawn; the other posterior end of the suture is passed over the outer surface of the rib, and the two ends are knotted together, so that the rib is thus encircled in a loop which suspends the kidney. It is very important to place the kidney in its proper position before knotting the first suture; the surgeon pushes the kidney upwards so that its upper third is hidden by the lower ribs; he holds the organ vertically whilst the assistant ties the loop which surrounds the rib. The posterior ends of the suture having been thus secured, the anterior ends are made to encircle the rib, and tied in the same manner. The two anterior ends of the middle suture are tied so as to embrace between them a part of the anterior cut edges of the muscular wall; the posterior ends of the same suture encircle in their loop the quadratus lumborum, and even a portion of the sacrolumbalis. The corresponding ends of the third double suture are tied like those of the second. On tying together the two ends of each double suture the traction is made upon the knots at the entrance and exit, not upon the parenchyma of the kidney.

A necessary precaution to observe is only to pass the threads through the deep part of the muscular portion of the edges of the wound, and not through their whole thickness. In this way a solid plane of muscular tissue can be made to cover the fixed kidney, and thus separate it from the deep surface of the skin. Contact is assured between the posterior surface of the kidney and the lumbar parietes, and the adhesions which are produced make the contact permanent, with the result that there is cohesion between the gland and the muscles.

The superficial muscular layer is sutured with catgut and the skin with silkworm gut. A drain tube is or is not employed, according to the particular case. Most frequently it is not employed. Three weeks is the period stated during which it is indispensable for the patient to remain on his or her back.

My own method.—This consists in attaching the kidney by means of three sutures dipped deeply into the posterior surface of the organ and running for from three-quarters of an inch to an inch in its substance. I have used various materials for sutures—stout catgut, kangaroo tendon, and silk, but now always employ silk. The accompanying figure will assist the explanation of my method of inserting the sutures.

My usual oblique lumbar incision having been made, I draw the kidney, and with it the divided edges of the adipose capsule, well up into the wound, and cut or tease a considerable part of the latter away, so as to diminish the space in which the kidney has wandered, and to prevent this cellulo-fatty tissue from subsequently bulging between the renal surface and the lumbar parietes. I then insert sutures into the renal parenchyma in the following way: Three sutures are passed deeply into the posterior surface of the kidney, one nearer the upper, the other nearer the lower end, and the third midway between the other two, but nearer the hilum. Each suture is buried for a length of three-quarters of an inch within the renal substance, and penetrates about half an inch into the thickness of the organ. The upper suture passes through the upper edge of the shortened adipose capsule, the transversalis fascia, and the deep layer of muscles, and is tied to them; the lower suture is similarly passed through and tied to the lower edges of the same cut structures; and the

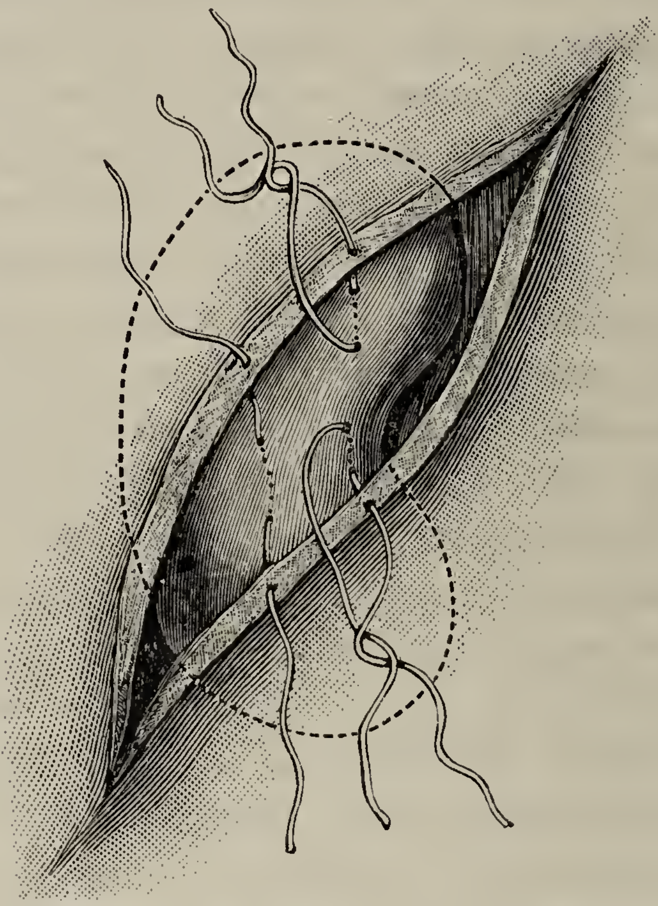

Fig. 129.—Author's method of fixing the Kidney. Left kidney shown. The sutures are represented in the figure too near to the hilum.

intermediate suture is passed through both edges of the divided adipose capsule, fascia, and muscles, and lashes all up together. The sutures are cut short and buried in the wound. A drain tube is frequently inserted down to the kidney, and the cut edges of the lumbar muscles and skin are brought together by silk sutures passed through all the different layers. The wound is dusted with iodoform or aristol, and covered with dry dressing. It usually heals in a week. The patient is kept in bed from four to five weeks. A further trial of Vulliet's method has convinced me of the satisfactory results obtainable from it; and I now employ it frequently instead of my own method. I like it quite as well as any of the methods of decortication, except for the fact that it takes rather longer time to perform, and the patients sometimes complain of a good deal of pain along the spine for a day or two afterwards.

Method of Bazy.—Bazy* adopts a method for fixing a movable kidney which he calls **Nephropexia en-hamac**. He has practised it since 1885.

He makes the usual lumbar incision to expose the back of the kidney. Three catgut sutures are then passed transversely under the fibrous capsule of the kidney at a distance of three-quarters of an inch from one another, the first at the middle of the vertical measurement, the third close to its lower pole, and the second midway between the two. The ends of the first suture are passed, at a distance of an inch from each other, through the eleventh intercostal space. In one case Bazy perforated the pleura, but no harm resulted. The ends of the other sutures are drawn through the muscles close under the twelfth rib and tied. Thus the kidney is made to lie well up against the ribs. The cellulo-adipose tissue is drawn up by a series of stitches under the kidney, and there held by a catgut suture passed through the tissue from outside the muscles below the last rib, and tied. Thus the kidney is supported below by a kind of hammock of fat.

Choice of method.—Although I have described a method of my own which I have employed in a large number of cases, I by no means limit myself to one plan of operating.

When I operate upon a case of simple, uncomplicated, movable kidney, especially in a feeble woman, or when for any other reason it is desirable to shorten the operation as much as possible, I greatly prefer my own method.

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* *Bull. et Mém. de la Soc. de Chirurg.*, Oct. 31, 1899.

When, on the contrary, the fixation of the kidney is only one of the objects served by the operation, and an exploratory incision of the kidney has also to be made, I adopt the principle of decortication which was first employed by Tuffier in his experimental work on dogs, but without transfixing the parenchyma as Tuffier does. I detach the capsule for about three-quarters of an inch on each side of the incision along the convex border of the organ; and after suturing the edges of the divided parenchyma together as in ordinary exploratory operations and in nephrolithotomy I attach the deflected capsule to the deep tissues in the edges of the parietal incision.

Since its introduction, four or five years ago, I have practised Vulliet's operation in several cases on young female patients, and in one or two cases I have thus successfully operated upon both kidneys of the same patient. This operation answers its purpose exceedingly well; the kidney by it is thoroughly drawn up into its place and maintained there; and time and muscular exercises, so far as I have yet been able to observe, do not seem to impair the excellence of the immediate results. It must be admitted, however, that the tearing out of the tendon is followed frequently, not always, by a good deal of pain along the spine; and in two cases in which the patients were very restless when recovering from the anæsthetic, who were the subjects of a considerable leucorrhœal discharge at the time, but of which I was informed only after the operation, the small wounds near the spine suppurated, although in each case the lumbar wound healed by first intention. In spite of these drawbacks, Vulliet's method is well worthy of ranking amongst the best of the methods of fixing the kidney: by none of the other methods have I obtained better results.

If it were proved that the proper capsule of the kidney prevents firm adhesions forming between it and the apposed tissues, as Tuffier believes, then it is clear that one or the other of the methods of decortication must be employed to secure success. But experiments on animals, the distant clinical results of operations on man, as well as the evidence afforded by dissection, a year or more after fixation by means of the non-decortication methods, prove most conclusively that it is not necessary to strip off the least portion of the fibrous capsule in order to obtain the firmest union between the kidney and the tissues against which it is sutured.

I see from time to time patients upon whom I operated nine or ten years ago with their kidneys as firmly fixed as can be desired, and who have been quite free from their former symptoms ever since the operation. Moreover, I have had the opportunity of witnessing in the living bodies of some three or four of my patients the sound and complete holdfast which my own method affords. It has happened that from six to twelve months or longer after fixing a hydronephrotic and in a few cases after fixing a healthy kidney I have had to perform a second operation for other reasons upon the same organ: and I have then seen my sutures embedded in a mass of tough fibrous tissue between the kidney and the lumbar parietes, and have had to pull or cut them out from the renal parenchyma before I could detach the kidney. Here they had for months harmlessly remained without showing the least tendency to become the nuclei of calculi, or tubercle, as some surgeons anticipated would be the case.

Experiments have shown that the intact true or fibrous capsule of the kidney, when brought up to the surface of the body and placed in contact with an antiseptic dressing, is capable of proliferating, that the proliferated tissue becomes incorporated with the cutaneous cicatricial tissues, and a solid fixation of the kidney results.

Tuffier himself seems to admit that cicatricial bands are formed between the renal capsule and the parietes around the suture tracts, but thinks they are insufficient to support the kidney as well as the large bowel (cæcum), which is displaced with the kidney.*

Tuffier, whose admirable experimental work published in 1889 on this and other branches of renal and ureteral surgery is well known, is of opinion that the parenchyma, where the sutures constrict it, becomes sclerosed and atrophied. This condition did not appear to have been caused in the kidneys I have just referred to; nor is there any reason that it should. It is only when the sutures are pulled tightly around a mass of renal tissue that these results follow; and in fixing the kidney by the method I adopt and recommend, the renal parenchyma is not constricted but merely held by the sutures sufficiently firmly to keep the surface of the organ in contact with the loin. But even if sclerosis or atrophy did ensue, its area would be very limited and the amount of the kidney tissue so affected would be small, and could easily be spared without danger to the

* "Études Expérimentales sur la Chirurgie du Rein."

individual. Moreover, it would be less extensive than the superficial sclerosis which follows the decortication of the renal cortex.

As to the danger mentioned by Barth of necrosis of the parenchyma owing to the occlusion of one of the arterial arches by the anchoring suture, or the danger referred to by M'Ardle of necrosis following puncture of one of the large arteries which had been obstructed by a hæmorrhagic infarct, there need be little fear, if the sutures are not pulled upon too tightly, and if they are kept clear of the "large arteries," which is done by the manner I adopt of dipping the sutures into the organ on the posterior surface instead of making them traverse the organ from surface to surface. As to the "dangers arising from sepsis, and from the lethal phlebitis to which this operation exposes the patient," so gloomily pictured by Mr. M'Ardle,* the answer is found in the almost entire absence of mortality after the operation. I have now operated for movable kidney in more than eighty cases without a death. Tuffier has operated in seventy-five cases with two deaths, and he gives statistics of 173 collected cases (in which collection mine are not, I believe, included) with a mortality of 4·4 per cent. for all operators. If a method of decortication is employed it is unnecessary to transfix the renal substance; and perfect results can be obtained without using nearly so many sutures as Jacobson advises, or splitting up the capsule into little triangles as Lane does.

Abdominal or trans-peritoneal nephrorraphy or nephropexy can scarcely be said to exist as a recognised operation.

When performed, it has either been (*a*) in the course of some abdominal exploration or operation owing to the mobility of the kidney being incidentally discovered, or (*b*) it has been deliberately undertaken under mistaken and altogether erroneous notions as to the difficulty of obtaining and retaining grasp of the kidney and effecting the denudation of it, when movable, by the retro-peritoneal lumbar method.

(*a*) Greig Smith † in a case of mistaken diagnosis opened the abdomen and found a movable kidney; he succeeded in fixing it by scratching its capsule freely with a needle pushed through the abdominal wall, while the hand inside the abdomen pressed it against the loin. Le Dentu, referring to this, which he calls a "singular operation," remarks: "No one will be astonished that so imperfect an operation did not secure any benefit to the patient."

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* *Brit. Med. Journ.*, 1894, vol. i., p. 526.

† *Lancet*, 1884, vol. ii., p. 10.

(*b*) Harvey Reed of Columbus, Ohio,* describes "a new method for anchoring the kidney." It is apparently based upon a very exaggerated idea of the difficulty of manipulating a floating kidney and holding it in a fixed position long enough to securely suture it. The operation consists "in making the ordinary perpendicular abdominal incision over the median line of the kidney." The fingers are then passed across the peritoneal cavity to fix the kidney steady in its normal place, whilst two sutures of aseptic silkworm gut or silk are passed through the cortical substance of the kidney and tied on the integuments of the patient's back. The sutures are passed by means of special needles from 5 to 7 inches in length, made expressly for the purpose. The first needle is made to come out between the eleventh and twelfth ribs.

So little to be recommended is this operation that I need not further describe it, but must refer the reader who wishes for more particulars as to its mode of performance to the original paper. The author claims for it the following advantages: (1) simplicity, (2) rapidity, (3) efficiency. To me it seems to be unnecessarily complex, uncertain, and involved, and to have the additional drawback that the first needle must necessarily pass through the *cul-de-sac* of the pleura.

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* *Journ. of the Amer. Med. Assoc.*, 1894, Dec. 22, p. 948.

CHAPTER XXXI.

OPERATIONS ON THE KIDNEY, AND THE METHODS OF PERFORMING THEM (*Continued*).

Nephrectomy.

The operation of nephrectomy or excision of the kidney as practised at the present day may be either partial or complete, that is, either one or more segments or wedges may be excised, or a third or a half of the organ may be removed, or the whole organ may be taken away.

Total nephrectomy may be either primary or secondary. By primary nephrectomy, when performed for disease, is meant the removal of the organ at the first operation; by secondary nephrectomy is understood its removal after nephrotomy has been tried and failed to effect the end desired. When performed for injury, primary nephrectomy is the immediate removal of the kidney; secondary nephrectomy its removal after an interval of days, weeks or months, whether or not drainage has been tried or suppuration has set in.

The kidney may be removed with its fibrous capsule intact: this is pericapsular nephrectomy. Or the proper capsule of the organ may be stripped off and left behind in the wound, only the kidney itself, without its capsule, being taken away: this is "subcapsular" nephrectomy. Finally, within the last ten years it has been the practice of some surgeons who have had large experience in renal surgery to remove, in certain cases, especially of tuberculous disease, a large part or the whole of the ureter with the kidney. This operation, which I anticipate will in time be much more extensively employed than at present, is known as nephro-ureterectomy.

Several different methods of removing the entire kidney have been adopted. These will first be described under the heading of "Nephrectomy." The removal of parts only of the kidney will be subsequently described under the heading of "Partial Nephrectomy."

Ureterectomy will be fully described in Part II. of this work (*post,* p. 624), the removal of a considerable portion of the ureter together with the kidney, will also be considered in this chapter.

Nephrectomy, or the total removal of the kidney from the living body, was first performed as a planned operation, and by the lumbar method, in the human subject by Gustav Simon of Heidelberg in April, 1869.

With this operation began the dawn of renal surgery. It is impossible in this place to give the history of the rise and progress of this branch of the surgeon's art. The reader will find information on this interesting subject in the fourteenth volume (1880) of the *Clinical Transactions,* in Küster's and in Le Dentu's works, and in the "Hunterian Lectures," 1898, by the present author. A more recent and very excellent account has been published by Pilcher.

LUMBAR NEPHRECTOMY.

Conditions for which performed.—It should be performed in cases in which the removal of a disorganised kidney is advisable after nephrotomy has been tried, and failed to improve the condition of the patient; in certain advanced cases of calculous disease; in all cases of pyo-nephrosis which require excision; in certain cases of incurable ureteral urinary fistula; in cases of wounded or ruptured kidney which are injured past the probability of functional repair, or in which blood-clots are being forced into the ureter and plug it so as to lead to urinary extravasation into the loin, or to acute nephritis of the injured organ and threatening symptoms of secondary peritonitis. It should also be selected for hydro-nephrosis, renal cystic tumours, and medium-sized solid tumours of the kidney, and for cases of painful movable kidneys, if there are any such, which should rightly be condemned to removal. Some cases of large kidney are best removed by means of a combined abdominal and lumbar method, which will be described further on; or by the abdominal or trans-peritoneal method alone. The particular method will be decided according to the preference of the operator.

Certain rare cases of wandering kidney affected by hydro-nephrosis, calculous pyo-nephrosis, or other disease, and cases in which a wandering kidney is very loosely held by a mesonephron if the removal of the kidney is indicated, are better dealt with by the abdominal method. I endorse the teaching of Simon, who laid it down as a cardinal principle that extirpation of a kidney is only permissible when a patient's life is seriously threatened by disease, and all other remedies have failed. Renal disease is more dangerous in persons with only one kidney. The suffering caused by a movable or floating kidney ought to be quite unrelievable by other means, or the organ ought to be otherwise diseased, before the patient is deprived of it.

The operation.—Total nephrectomy is best performed by the transverse or slightly oblique incision employed for nephrolithotomy and nephrotomy; with this may be conjoined a second incision, running vertically upwards or downwards from the first, and starting from it about one inch in front of its posterior extremity. In making the first incision the operator should start from half an inch to three-quarters of an inch below the twelfth rib to avoid wounding the pleura, which sometimes descends a little below the lower edge of the rib (*see* p. 174, Vol. II.). It should be continued as far forward as necessary, to give ample room. The second incision may be left until the kidney has been reached and explored, and it can then be made by cutting from within outwards with a probe-ended bistoury, steadied by the index finger of the left hand. One great advantage of the vertical incision is the increased facility it affords for passing the ligature around the pedicle. The upward cut often gives very greatly increased room for manipulation by dividing the ligament of Henle, the lower edge of which hampers the fingers during the enucleation of the upper end of the organ. If made in the manner described under Nephrotomy, by pushing upwards the soft structures on the deep aspect of the upper border of the wound with the left index finger before cutting upwards, the pleura is sufficiently safeguarded. In certain cases enormous advantage is gained by excising a large part of the twelfth rib. This is done in the manner described under Nephrotomy, and the description need not be repeated here (*see* pp. 209–10, Vol. II.). M. Tuffier, who refers to the subperiosteal resection of the twelfth or of the last two ribs as a means of overcoming the difficulty of reaching the upper limit of the kidney, speaks of it as having been "generally abandoned in spite of the pleading of d'Antona at Moscow in 1897." On the contrary, I have been more persuaded of its value each time I have had recourse to it; and I never attack a large calculous or tuberculous pyo-nephrosis without being prepared to remove part of one or both of the two lowest ribs. I have very rarely found that the removal of the twelfth alone has failed to give me all the room I needed. I have never resorted to it in cases of solid new growth, my plan of combining Langenbuch's with the lumbar incision in these cases rendering the excision of the rib unnecessary. Other lumbar incisions have, however, been employed: vertical, transverse, curvilinear, and the vertical with the transverse or curvilinear combined. It is not necessary to describe them all. One, however, which has met with some imitators in America, has been described by its originator, König of Göttingen, as "the retro-peritoneal lumbo-abdominal" incision.

König[*] divides the soft parts vertically along the outer border of the erector spinæ downwards nearly to the iliac crest, then directs the incision towards the umbilicus as far as the outer border of the rectus abdominis, or even goes forwards through the rectus to the umbilicus. Everything is divided except the peritoneum, which is detached and pushed inwards so as to escape division in the anterior part of the wound. I agree with Mr. Treves,[†] who says of König's method: "This incision, known as the retro-peritoneal lumbo-abdominal incision, gives plenty of room, but it is needlessly extensive. It involves a very considerable division of muscular fibre, and is very likely to be followed by a ventral hernia. When such an extensive exposure of the renal region is called for, it is better that Langenbuch's incision should be employed."

The kidney being reached, the next step is to separate it from its surroundings. This is done in most cases by means of the fingers, the areolo-fatty tissue peeling off in many cases with great readiness. If, however, there has been much intra-renal irritation with circumrenal inflammation, the adhesions of the surrounding tissues to the fibrous capsule of the kidney will be dense and tough, and the aid of some cutting instrument will be required. It is much safer to employ scissors or scalpel under these circumstances, cutting close to the fibrous capsule. When no circumrenal inflammation has existed, the colon and peritoneum, as well as the fatty tissue, will easily be detached from their connection with the kidney by the index finger of one hand working close against the capsule of the organ. It is sometimes found that even when no inflammation has occurred some of the renal capsule will be torn off and left behind; in other cases, as when the operation is performed for calculous or scrofulous pyo-nephrosis, and as a proceeding subsequent to nephrotomy, the kidney has to be enucleated from its thickened and firmly adherent capsule, and the latter left behind with the pedicle. This subcapsular operation is very inferior to the ordinary nephrectomy, and should never be performed, except when it is dangerous to the life of the patient or to the integrity of the surrounding organs — *e.g.* colon, diaphragm, vena cava, or aorta — to attempt or to persevere in attempting the removal of the proper renal capsule. A laceration (one or more) of the peritoneum, which can easily be closed by continuous sutures, should not deter the surgeon from removing the capsule, though the more important adhesions must do so. Besides leaving behind a large cavity with rigid unyielding walls, the subcapsular nephrectomy is apt to be followed by very troublesome or incurable fistula, or to lead to the formation of a tumour by the distension of the sac, as in a case I reported in the *Lancet* for January 1, 1898.

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[*] *Cent. f. Chir.*, 1886, Heft 35.

[†] "A Manual of Operative Surgery," vol. ii., p. 498.

Treatment of the pedicle.—The next step is to pass a double ligature of plaited silk through the pedicle, between the ureter and the vessels. This is done by means of an aneurysm needle fixed in a long handle, whilst the kidney is dragged well up into the wound by the left hand of the operator, one of the fingers of which can at the same time be acting as a guide for the needle. The needle passed and withdrawn, the ligature silk should be divided, and one-half of it should be tied tightly around the vessels and the other half around the ureter. The ureter should be ligatured first in cases in which it is not obviously thickened or diseased. Two ligatures, or a ligature below and a pair of compression forceps higher up, should be applied and the ureter divided between, taking care to protect the surrounding structures from any fluid which may escape from the ureter at the divided part, by surrounding it with a sponge or other aseptic compress. If the ureter is thickened or diseased, it should be left until after the vessels of the pedicle have been ligatured and divided, and then it should be followed down as far as the brim of the true pelvis, or lower, and there ligatured with a medium-sized silk ligature, and divided between the ligature and forceps with the precautions which have just been stated; the kidney and ureter are thus removed in continuity with each other. The cut end of the mucous membrane of the ureter above the ligature should be well scraped or erased, excised or cauterised, and the surface of the tube should be rubbed with carbolic acid or iodoform emulsion, and dropped back into the wound. In tying the vessels of the pedicle the ligatures should be pressed well inwards towards the side of the spine, so as to leave plenty of room between the ligatures and the hilum for dividing the pedicle. The kidney should now be drawn quite out of the wound, a proceeding which is sometimes very difficult, but which will be greatly facilitated by dragging the lower ribs forcibly upwards with the fingers of the left hand dipped into the wound. I would lay special emphasis on this point, when excision of the last rib has not been performed, as being of much assistance in this step of the operation. Another ligature should be thrown round the pedicle, and very securely tied, or with a pair of large curved Spencer Wells' forceps the pedicle on the renal side of the ligatures should be fixed before cutting the kidney free. After snipping through the vessels with a pair of blunt-ended scissors, if the pedicle is thick and contains an abundance of fibro-fatty tissue, it may be found that the vessels have not been firmly compressed by the ligatures, and if so it will be well to take up the vessels individually after tying them *en masse* and dividing them as just described.

Any bleeding points should at once be seized and ligatured; and it is very probable that when the wound comes to be fairly looked into, as it can be after the kidney is cut away, some moderate-sized vessel will be found bleeding. Some aberrant branch of the renal, or one of the inferior suprarenal arteries, or the branch to the upper end of the ureter or to the connective tissue of the loin (all branches from the renal trunk), or one of the parietal branches of the aorta, may require control.

All the ligatures should be cut off short, and the pedicle dropped into the wound. A drainage tube should be fixed in the wound, the edges should be brought together with silk or fishing-gut sutures, and a thick layer of dry aseptic dressing should be applied. The patient should be kept in the recumbent position until healing is complete, and the drainage should be kept up for four or five days. Healing is, as a rule, rapid, and is often complete within a fortnight or ten days, or less. The greater part of the wound heals immediately by direct union, though the drainage track will require from six to eight or ten days to close perfectly. Some surgeons attach importance to the separate ligature of the artery, vein, and ureter; but the important thing is to securely control the vessels without putting too great a strain upon them in doing so, and without running the risk of their slipping behind the ligatures when a quantity of condensed tissue has had to be included with them. It is a great advantage to have the kidney well up into the wound or, still better, out upon the loin, before cutting it away; but to attempt in all cases to get the kidney on to the cutaneous surface before ligaturing the vessels would be to run a great risk of lacerating the coats of the artery or vein nearer the spine than the point at which it is possible to apply the ligature.

The dangers of the lumbar operation are that (1) the peritoneum or the colon may be torn open; (2) too great strain on the vessels of the pedicle may cause their laceration, or the ligatures may slip after the kidney has been cut off; (3) the kidney may be broken in the manipulations for separating or withdrawing it. All these accidents have occurred, but they are not necessarily very serious. The laceration of the kidney requires the hæmorrhage to be controlled by pressure, and by hastening the completion of the operation; a great safeguard against hæmorrhage from laceration is the application of the double ligature before attempting to withdraw the kidney. If the ligatures have slipped, or fail to control the vessels of the pedicle, or if troublesome hæmorrhage from any source arises, it will be best immediately to seize the vessel with one of Wells's large ovariotomy forceps, and then permanently secure it with a ligature. If the colon or peritoneum be torn, the rent should be closed by Lembert's sutures; or the peritoneum may be closed with a continuous suture.

LATERAL RETRO-PERITONEAL NEPHRECTOMY.

In this operation a longitudinal incision is made further out than the linea semilunaris. Its exact distance from this line will depend on the size and prominence of the tumour. The object is to place the parietal incision sufficiently to the side to permit the enucleation and removal of the tumour by stripping up the peritoneum without opening the peritoneal cavity. It will usually extend vertically upwards from the anterior superior spine of the ilium, or from a spot slightly posterior to this, to or slightly over the costal margin.

After cutting through the various layers of the abdominal wall till the peritoneum is reached, this membrane is stripped off the tumour and displaced inwards. The pedicle is dealt with as in the other abdominal operations.

This method has no advantage that I know of over the lumbo-ilio-inguinal incision (*see* Fig. 122, p. 132). Its advantage over the trans-peritoneal operations is in not opening the peritoneal cavity. In cases in which hæmorrhage is anticipated it is not so well suited as the trans-peritoneal abdominal incision, because the trunk vessels cannot be so well controlled by pressure before the peritoneum is stripped up. Greig Smith was of opinion that it is less easy to reach and deal with the pedicle by this method than by Langenbuch's incision. Treves considers the risk of ventral hernia is increased by this method. I have seen it on one occasion employed by a colleague, and in that case from what I saw of the operation it answered very well. Jacobson has employed it in one case of malignant disease in a movable kidney, and was much struck by the room afforded by it. He found no difficulty in dealing with the pedicle—first the ureter, and then the vessels. About one inch and a half of the vena cava was seen during the operation. The patient, however, never rallied from the operation, and died about twenty-four hours afterwards. The ligature upon the renal vein had slightly puckered up the vena cava.

ABDOMINAL NEPHRECTOMY.

Abdominal nephrectomy is performed by those surgeons, comparatively few, who are uncompromising advocates of the trans-peritoneal method, in just the same classes of cases in which the lumbar operation is performed by the great majority of operators. These cases have been specified on p. 239. The surgeons who operate by the lumbar method reserve the abdominal or the combined abdominal and lumbar operation for large neoplasms of the kidney—for injuries of the kidney when laparotomy is essential to make sure as to the precise nature and extent of the damage done to the viscera, and for those rare cases of diseased floating—as distinct from movable—kidney in which it would be difficult or impossible to manipulate or enucleate the organ from the loin.

Operation.—The best incision is that which many of the old surgeons employed in all abdominal sections, and which Langenbuch of Berlin recommended and practised in nephrectomy,* namely, along the outer border of the rectus abdominis on the side of the kidney to be removed. It should at first be made large enough to admit the whole hand, and subsequently enlarged as required, as far as possible. The mid-point of the incision will probably be on a level with the umbilicus, but this must entirely depend upon the size and outline of the tumour. The linea alba is preferred by some surgeons.

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* *Transactions of the International Congress*, 1881, p. 278.

All bleeding, and it is sometimes considerable in the lateral incision, being stopped, and the peritoneal cavity opened, the existence of the opposite kidney should be confirmed by digital examination. The intestines should be kept off the surface of the kidney to be removed, by means of a large flat sponge introduced into the abdomen. The outer layer of the mesocolon should then be incised sufficiently to allow of the introduction of two or three fingers behind the peritoneum and into the fat in front of the kidney; the fingers should then gently tease their way towards the renal vessels, around which ligatures should be applied. If the vessels are tied separately, care should be taken to secure the artery before the vein. The ureter should then be traced downwards to the pelvis and ligatured as low as possible, and divided between the ligature and a pair of clamp forceps placed higher upon the duct. Langenbuch's object in selecting this incision was to divide the outer layer of the mesocolon, and so to avoid the risk of hæmorrhage, and of gangrene of the bowel, which are prone to occur if the peritoneum is divided on the median side of the gut. Such a division of the mesocolon would be across the course of the vessels, since the inner layer of the mesocolon covers the vessels passing to the ascending and descending colon. The enucleation of the tumour should next be proceeded with; lastly, the vessels should be divided, and the mass removed from the body.

The treatment of the ureter after abdominal nephrectomy has given rise to differences of opinion. Tuffier, following Thornton, considers it better, when the operation is performed for a septic condition, to fix the ureter to the abdominal wound rather than to make a *boutonnière* in the loin and attach the cut end of the tube there at the outer edge of the quadratus lumborum muscle. The latter plan, which I had advocated, can readily be practised by cutting down from the loin upon a director thrust towards the skin from within the abdomen, seizing and passing the cut end of the ureter through the loin wound, and fixing it there.

Treves remarks, and as I think rightly, that the "proposal to bring the end of the diseased ureter into the parietal (anterior abdominal) wound and to fix it there has been properly condemned on the ground that the ureter so fixed would form a rigid and possibly troublesome intra-abdominal band, and that the septic discharge from the tube might interfere with the healing of the abdominal wound."

The plan of dealing with the ureter which I consider simplest and best, and which I always adopt, is to trace it down as low as possible without unnecessarily lengthening the wound, to ligature it and divide it about a quarter of an inch above the ligature, taking care in doing so to prevent the few drops of fluid which may escape from fouling the tissues, by putting a sponge or swab of aseptic wool so as to catch whatever escapes. If the ureter is normal, no more needs to be done with regard to it; if, on the contrary, it is septic, the mucous membrane lining it should be erased and the stump should be treated with carbolic acid or iodoform emulsion; if tuberculous, the same treatment should be employed, and the whole of the wall of the stump of the tube should be well rubbed with iodoform emulsion and then dropped back into the cellular tissue and covered over neatly with the peritoneum.

It is unnecessary to suture the divided edges of the mesocolon; it will be sufficient to replace the peritoneum evenly over the area from which the kidney has been removed, and a drainage tube should be carried through an opening made for the express purpose in the loin, near the outer edge of the quadratus lumborum. This is a most desirable precaution in aseptic cases so as to provide an exit for the blood and serum which are so prone to escape during the first few hours into the large space from which the kidney has been removed; if any septic material has escaped from the kidney into the cavity left by the operation then drainage becomes absolutely essential.

The abdominal wound after nephrectomy is closed in the usual way, and the same dressing is applied as after ovariotomy.

Though in some cases from the size of the tumour the abdominal operation is easier and safer, the lumbar method is, as a rule, much safer, and is to be preferred in all cases where the kidney is not greatly enlarged, where the kidney is septic, where the tumour can be reduced by puncture, and where the loin space is not too much contracted.*

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* For a careful analysis of the earlier results of the various operations on the kidney, based on nearly four hundred and fifty cases of different operations, I would refer the reader to Professor S. W. Gross's article: "Nephrectomy: its Indications and Contra-indications," in the *American Journal of the Medical Sciences*, July, 1885.

"There is nothing to recommend a drainage tube introduced through the abdominal wound" (Treves).

Terrier has recommended the drainage of the cavity from which the kidney has been removed through the front of the abdomen, after shutting off this cavity from the general peritoneal cavity by means of sutures, and suturing the central parts of the posterior peritoneal incision with the cut edges of the peritoneum of the abdominal wound.

Mr. Barker also states that it is well to unite the anterior lip of the wound in the mesocolon with the anterior lip of the peritoneal layer of the abdominal wound, so as to shut off the perinephric space from the general cavity of the abdomen. Mr. Thornton seems to have followed this plan in one case, with the result that acute intestinal obstruction occurred, for which enterotomy was performed, and the patient died.

Method of Terrier.—Terrier has recommended* a transperitoneal operation which differs in one respect only from the ordinary abdominal nephrectomy, the modification being designed apparently to do away with the necessity of drainage through the loin.

The incision of the abdominal wall may be either along the linea alba or linea semilunaris, depending upon whether the tumour is more prominent at the one or the other; but preference is given to the median line when the diagnosis is not absolutely certain. In either case the incision should be very free, so as to allow of ample room for inspection and manipulation. The cavity of the peritoneum being opened, and the small and large bowel pressed over to the opposite side of the abdomen, a vertical incision is carefully made into the posterior layer of the peritoneum covering the tumour, avoiding any vessels there may be. This done, three or four pairs of pressure forceps are to be applied to each of these edges of the peritoneum, with the object of being easily able to find them after the tumour has been enucleated and removed. There is nothing special in the subsequent steps of the operation until after the tumour has been cut away; except that Terrier first applies curved clamp forceps to the pedicle, and subsequently ligatures the vessels when the tumour has been removed. The ureter he isolates, and either brings its end out at the lower part of the abdominal wound or drops it back after ligaturing it. Now comes the special feature of the operation. The edges of the incision in the posterior layer of the peritoneum are drawn up by the forceps attached thereto; if this incision is very long, it may be curtailed above and below by a few sutures of aseptic silk or catgut. This done, the edges of the unclosed part of the incision are drawn outwards and fixed to the edges of the anterior abdominal incision, which has previously been in part closed by deep sutures placed above and below the point at which it is most easy to fix the two lips of the incision in the posterior layer of peritoneum. In this fashion the general cavity of the peritoneum is absolutely shut off from the retro-peritoneal space previously occupied by the tumour. This space is drained by two large tubes impregnated with iodoform powder and introduced through the sutured orifice in the anterior abdominal wall. It is recommended by Terrier to retain the drainage tubes till the tenth or twelfth day if the cut end of the ureter has been brought to the surface of the abdominal wound, or if when dropped back its aseptic condition can be assured; if not, the drainage tubes should be retained much longer.

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* "Remarques sur un nouveau Procédé de Nephrectomie Transpéritonéale," *Revue de Chir.*, Paris, 1887, No. 5, p. 342.

Nothing can prove the superiority of lumbar drainage more forcibly than this injunction of Terrier to keep up abdominal drainage for so long a time. Happily, nephrectomy by the lumbar method, and by the combined abdominal and lumbar incisions, needs only the retention of drainage tubes for three or four days at the outside, and many a patient operated upon by these methods is sitting up with wounds healed before the period for the removal of the drainage tubes in Terrier's operation.

The combined longitudinal and transverse abdominal incisions.—This method consists in making (1) a vertical incision, five or six inches long, in the linea semilunaris, opening the peritoneal cavity, and (2) an incision outwards to the loin from the middle of the vertical incision, dividing all the structures forming the abdominal wall, including the peritoneum. The intestines are crowded over towards the opposite side, and retained there by means of flat sponges; the peritoneum covering the tumour is then incised and stripped off, and the tumour is enucleated and removed as by the other abdominal methods. Dr. Hume of Newcastle employed this method for the removal of a renal sarcoma.* I have twice employed it with satisfactory results.

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* *Lancet*, vol. i., 1893, p. 196.

THE COMBINED LUMBAR AND ABDOMINAL NEPHRECTOMY.

Method of the author.—Although in the great majority of cases the lumbar operation is to be preferred, still for kidneys of great size, whether enlarged by new growth or distended by very large calculi or blood-clot, the loin wound alone does not give sufficient room. It is true that the loin incision, when prolonged as indicated in Fig. 122 (p. 132), allows of ample room for enucleating the largest renal tumours with which I have had to deal; but where hæmorrhage is to be anticipated, and it is desirable to compress or ligature the vessels before enucleating the tumour, and where the ilio-costal space is very small and greater facility is required for enucleating the upper pole of the kidney without excising the last rib, the abdominal incision is a very excellent adjunct to the lumbar, and allows of the latter incision being kept comparatively short, not exceeding 4 or 4½ inches.

If the diagnosis of the nature and connections of the tumour is not quite clear, I begin by making the front incision along the linea semilunaris; then, passing in my hand, I satisfy myself as to the bearings of the tumour and of the size and surface character of the opposite kidney. A flat sponge is then spread out within the abdomen beneath the edges of the parietal wound, and the wound is temporarily held together by one or two sutures tied in bows. The patient is then turned on to his sound side, and placed in the usual position for lumbar renal operations (*see* p. 177, Vol. II.). If the diagnosis as to the nature and connections of the tumour is quite clear and a second kidney is known to be present, I begin with the lumbar incision.

When the tumour has been exposed through the incision in the ilio-costal space, its posterior surface is thoroughly freed from the perinephric fibro-fatty capsule, and when this has been completely accomplished the wound is plugged with a sponge and covered temporarily with an aseptic dressing. The patient is now placed in the dorsal position, and through the abdominal incision the peritoneum on the outer side of the colon is divided, after pressing to the opposite side the coils of small intestine and the colon, and covering them and keeping them back by means of large flat sponges. The proper fibrous capsule of the kidney will now be reached, and the enucleation of the kidney from the perinephric tissue can be proceeded with by means of the fingers. During the process of enucleation any bleeding vessels should be controlled with pressure forceps. It sometimes happens that very large veins, especially when the left kidney is the one involved, course over the front of the tumour. I have seen them as large as the index finger. They must, of course, be avoided, and to this end the peritoneum on the outer side of the colon may have to be divided obliquely or transversely, rather than vertically. If the renal capsule is very thin over part of a new growth, or over a projecting branch of calculus, or a bulging area of a hæmato-nephrosis, it will be desirable to clear a way first to the pedicle and secure at once the renal artery and vein separately (the artery being first ligatured), if they can be readily distinguished. In all cases in which the renal pedicle is not thickened, indurated, or otherwise altered by an overgrowth of fibro-lipomatous or inflammatory tissue, the separate treatment of renal artery and vein is easily effected. In cases of new growth the renal pedicle is generally quite supple, and the separate vessels or their main branches can be readily seen or felt. In calculous pyonephrosis or hæmato-nephrosis, in tuberculous disease, and speaking generally where there has been much or long-standing perinephritis, the pedicle is often very thick and tough, the vessels cannot possibly be defined, and the whole pedicle must be included in ligatures, which transfix it, or it must first be clamped in a pair of large, slightly curved pedicle forceps, and the vessels subsequently isolated and ligatured in the cut surface of the stump.

Whether the renal vessels are secured early or late, the whole of the front surface, the inner and outer borders, and the upper and lower extremities of the tumour are cleared of their connections with the fingers, and when freed throughout of its parietal attachments it is delivered through the anterior incision. This part of the operation is very greatly facilitated by pressing forward the tumour with the fingers of one hand in the lumbar wound, whilst with his other hand the surgeon manipulates it and guides it through the abdominal opening. During the delivery of the tumour an assistant should support its weight and prevent it from falling and suddenly tearing away any undivided tissues. I would specially enforce this precaution. It once happened, when I was removing a large renal sarcoma, that the tumour dragged suddenly away, after it had been brought out through the anterior wound; as it did so it snapped a long, slender adhesion, which recoiled instantly into the space from which the kidney had been extracted. Immediately there was an outpouring of venous-looking blood, alarming to witness, and which gave the momentary impression that the vena cava must have been torn open. The source of the bleeding was a vessel several inches long which had coursed over the surface of the tumour, and had escaped detachment by the finger in the process of enucleating the kidney. The vessel was quickly seized and ligatured and cut short, and the patient made a good recovery, and was none the worse for the hæmorrhage; but the accident might have been more serious had the vessel given way at its origin from the main vessel, instead of at its renal extremity.

When the renal tumour has been delivered, the ureter should still remain connected with it, if the vessels of the pedicle have been capable of separate treatment. When this is so the ureter should be detached as low as possible, ligatured at its lowest point, clamped an inch higher up, divided in the interspace, and the stump treated as previously described (pp. 242 and 247 *ante*).

After cutting away the tumour, a careful inspection of the site from which the kidney has been removed should be made, all bleeding stopped, a large drainage tube inserted through the lumbar wound, the peritoneum and colon carefully adjusted into their places, and the abdominal wound and afterwards the lumbar wound closed and dressed in the usual manner.

SUBCAPSULAR NEPHRECTOMY.

In the description given above of lumbar nephrectomy mention is made of the plan of dividing the proper capsule of the kidney, and of enucleating the organ from its fibrous investment, and ligaturing the pedicle at the hilum from the inside of the fibrous capsule. This is subcapsular nephrectomy, an operation of such importance and comparative frequency that it demands a separate description. It may be done either by a retro-peritoneal or a trans-peritoneal operation.

Indications.—This operation is to be absolutely condemned in nephrectomy for new growths of malignant nature. It is impossible in some cases of nephrectasis, because the capsule itself alone forms the wall of the cyst, *e.g.* in hydro-nephrosis, pyo-nephrosis, and hæmato-nephrosis. In tuberculous disease it is much to be deprecated, because the capsule is often invaded by the tubercle bacilli; and the disease will persist if the renal capsule is left behind, as it often is. It is a misfortune, but a misfortune which occurs in cases in which there has been extreme or prolonged perinephritis, if the renal capsule cannot be detached from its investment and removed with the kidney but the kidney has to be enucleated from within its proper capsule. It is far better, when practicable, to dissect off with patience and care the surrounding tissues from the fibrous capsule than to run the risk of subsequent trouble by adopting the comparatively easy task of peeling the capsule off from the renal parenchyma. In denuding the kidney with its capsule intact the use of blunt-end scissors or the scalpel will be required, and it may be necessary to open the peritoneum, or even to sacrifice a portion of that membrane. I would here again draw attention to the possibility of a fresh tumour being formed by the accumulation of effused fluid within the renal capsule which is left behind (*see* Fig. 202, p. 630 *post*).

But there are cases in which the fibro-lipomatous tissue has become greatly hypertrophied, altered, and intimately incorporated with the renal fibrous capsule, in which to attempt to remove the capsule would injure the colon and diaphragm, as well as remove considerable parts of the posterior layer of the peritoneum. When this is the case subcapsular nephrectomy, unfortunately, is a matter of necessity.

The operation.—The operation can be performed either by the abdominal or lumbar route. All the earlier stages of the operation are the same as in pericapsular nephrectomy. When the kidney has been exposed, the fibrous capsule is incised in its whole length, the edges of the capsule are raised with forceps and separated from the parenchyma with the tips of the fingers. The capsule in many instances comes off quite easily; in fact, so easily that it not seldom happens, in cases of tough adhesion of the perinephric tissue to the fibrous capsule, that the organ is enucleated from within its proper capsule without any definite incision being made of the capsule, and almost before the surgeon is aware of the precise structures which are being parted from one another.

When the hilum of the kidney is reached, the whole mass of the pedicle can be either clamped with large curved clamp forceps and the kidney cut away, leaving the vessels to be subsequently ligatured separately as they are seen and seized in the cut section of the pedicle; or the pedicle can be transfixed with a long curved pedicle needle carrying a stout double ligature, and the pedicle mass tied in halves. When this is done it is best not to cut off the ends of the ligature, but to leave them long, to use as traction cords in the event of the arteries not being sufficiently controlled and of bleeding occurring after the pedicle mass has been divided. A greatly dilated renal pelvis often gives rise to trouble by the failure of sufficient constriction by the ligatures. In these cases the distended renal pelvis is often perforated by the transfixion needle, its breadth of tissue helps to fill the noose of the ligature, and when the kidney is cut away, the infundibulum recedes on the distal side of the ligature; the noose is thereby slackened, and the vessels bleed and require to be caught up individually and secured by separate ligatures. This trouble may be avoided by breaking through the tissue with the finger-tip on one side of the broadened infundibulum, and after tying the duct separately, carefully cutting it through, before tying the rest of the pedicle which contains the arteries and veins. After the kidney has been cut away and all the vessels have been secured, the capsule should be carefully examined, and if any of it can be trimmed off and removed so much the better. It is sometimes possible to take away the greater portion of the capsule, once the kidney has been got out of the way.

Piecemeal removal of the kidney.—In rare cases it will be found almost as impossible to separate the proper capsule from the renal parenchyma as it is to detach the perirenal tissues from the fibrous capsule. Under these circumstances the only alternative is to break off one portion after the other of the renal substance and ligature the part nearest the hilum. In such cases the stump is formed of renal tissue, and other parts of the kidney may also be left behind with the capsule. It is the only practicable measure, however, in very difficult cases, and, although a long convalescence must be expected, the surgeon may have the satisfaction of saving his patient and curing him of his malady by means of it.

SECONDARY NEPHRECTOMY.

This operation consists in excision of the kidney after nephrotomy for disease, or after lumbar incision and drainage; or at a late period after the accident in rupture or other injury of the kidney.

In these cases there will be direct adhesions between the lumbar cicatrix and the kidney; possibly there will be a fistulous track or two running down to the surface or into the cavity of the kidney.

The incision, in my opinion, is best made through the old cicatrix. Care should be exercised in cutting through the scar tissue, otherwise the renal cavity will be entered and bleeding from the divided parenchyma will ensue before the surgeon is aware into what structure he has inserted his knife. When once the renal substance is approached, it is not, generally, difficult to separate the organ from the cicatricial structures by lateralising the knife and dissecting the cicatrix away from the kidney. After this is done, the rest of the enucleation may be very easy or very difficult. If there has been much perinephritis it will be difficult, and the subcapsular removal may be imperative. On the other hand, in many cases in which a previous operation has been performed on the same organ, the perinephric structures will be found quite supple, and will be as easily detached as in the natural state.

Partial Nephrectomy.

A most important advance in the conservatism of the surgery of the kidney is the excision of diseased portions, instead of the whole of the organ. This step was a natural result of the establishment of nephrolithotomy as a sound surgical procedure. The fear of uncontrollable bleeding during the operation and the doubts as to the healing power of a kidney when cut into or otherwise wounded being once removed, the attempt to save the greater part of the organ when only a small portion was diseased or injured was bound to follow.

Tuffier's experiments on animals in 1888, and Barth's histological researches, supply ample proofs of the healing power of the kidney, even after extirpation of considerable portions, and instruct us as to the process by which this healing is accomplished. Paoli* of Perugia performed extra-peritoneal operations for resection of the kidney upon twenty-five dogs, cats, and rabbits, with perfect recovery, and published his results in 1890.

But such experiments were not really required to teach us that wounds of the human kidney readily heal. In 1883 and 1884 I collected for my work on Diseases of the Kidney a number of cases proving the cicatrising capacity of the human kidney after incised, punctured, lacerated, and gunshot wounds.

In 1890 I had the opportunity of examining a kidney which I had freely incised for exploratory purposes a month before, and which was removed from the body of a patient who died from hæmorrhage from a gastric ulcer. A linear scar extending through the cortex to the renal pelvis was the only evidence in the organ that an operation had been performed upon it. The kidney otherwise had the appearance of being perfectly healthy.

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* *Verh. des Internat. Med. Cong., Berlin,* 1890.

Similar proofs existed long before the days of renal operations, and might have given surgeons faith in the reparative power of renal wounds of their own making. On the contrary, it has been only by slow degrees, and comparatively recently, that they have become convinced that a free incision or a partial excision may be made without fear of dangerous bleeding on the one hand, or of a urinary fistula following the operation on the other hand.

The conditions for which *partial nephrectomy* has been performed are various. Probably the earliest operation performed in the human subject was by Sir Spencer Wells, who in 1883, whilst removing by cœliotomy a retro-peritoneal fibro-lipoma, unwittingly cut out about one-third of the left kidney. The patient recovered as if nothing unusual had happened. Thus in partial nephrectomy, as in total nephrectomy, the earliest experience of the operation on man was unexpected and unintentional.

Indications.—The operation has been performed for simple and hydatid cysts, small malignant and simple neoplasms, tubercle, traumatic abscesses, calculous pyo-nephritis, fistula, and in some cases of injury. Keetley, E. Owen, Bardenheuer, Nash of Wallsend, N.S.W., and others have, either as a primary or secondary operation, removed a large portion of the kidney, which in some cases amounted to nearly one-half, and which had been broken off by accidental violence.

Tumours which take origin from the renal capsule often adhere so firmly that in removing them portions of the parenchyma have to be taken away. Suprarenal capsular tumours, as well as tumours originating in the tunica adiposa, may necessitate the removal of a part of the kidney; although it is more likely that before they come to be operated upon they have so far involved or surrounded the kidney that the surgeon will have removed the organ with the tumour without knowing he has done so; or the kidney will have been so far injured in the course of the operation that it will be considered right to remove it.

Up to the present partial nephrectomy has been but rarely performed. Czerny, Kümmell, Waitz, Bardenheuer, Tuffier, Albarran, Postempski, Oscar Bloch, and myself have hitherto, I believe, been the only surgeons who have performed the operation for disease. Other surgeons have, however, cut away parts of the kidney in removing paranephric new growths.

I have performed partial excision for disease in ten cases; the conditions were tuberculous foci and tuberculous abscesses, traumatic abscess containing a secondary calculus, a cyst, and fistula. In different cases I have removed a quarter, a third, and nearly one-half the kidney for tubercle: in another case I excised three wedges of the renal parenchyma for tubercle, the incisions extending into the calyces. In a case of tuberculous abscesses I scraped out six breaking-down caseous masses in the kidney of a man aged twenty-eight: this was in 1892, and he remains well, I believe, at the present time. In another case a lady who injured her kidney some years before whilst hunting had two abscesses in the right kidney, in one of which was a small phosphatic calculus. In another case I excised a fistulous track running into the kidney by cutting away the surrounding parenchyma. In a more recent case I removed from a gentleman aged forty-eight the lower pole, involving one-third of the kidney, for tuberculous disease, together with two encysted spaces containing purulent fluid, in one of which was also a small calcareous concretion; one of these encysted spaces was the size of a thimble, the other of a marble—both were in the cortex, near the convex border. Of these ten cases, the last required total nephrectomy a week after the operation, because acute general pyelo-nephritis rapidly ensued. The patient has since (about three months after the second operation) died of general tuberculosis of the lungs. The other nine cases all recovered from the operations; but upon one I performed nephro-ureterectomy seven months after the partial nephrectomy; and in another, symptoms returned within a year. The rest have remained well up to the present, with one exception, viz. a woman from whose right kidney I removed a cyst and scraped out an abscess. She recovered entirely from the operation and lived for three years without any return of trouble in this kidney; then died of acute broncho-pneumonia.

Bloch, in 1896, collected eleven cases from foreign literature of partial excisions, the first being Czerny's, in 1887, performed for an angeio-sarcoma following injury. Of the other cases, three were done for cysts, of which one was a hydatid cyst; three for calculous pyelo-nephritis; one for puerperal pyelo-nephritis; one for renal fistula; one for a patch of interstitial nephritis mistaken for malignant growth; and one for a renal neoplasm of uncertain nature, probably a degenerating adenoma. Nine of these patients made good recoveries from the operation; in one a fistula followed, in another nephrectomy was subsequently required.

The operation.—The lumbar incision will expose the kidney, which should be detached from its parietal connections and drawn out upon the surface of the loin. The organ should then be well inspected and palpated, and the extent of the operation determined upon. Between the finger and thumb of the left hand the renal artery should be compressed whilst the incisions and excision are effected, or the parenchyma itself may be compressed. After the part has been removed, any bleeding vessel of size should be ligatured, but in most cases bleeding will stop by pressure between finger and thumb, or when the cut surfaces are brought together by sutures.

If one or more cysts, small abscesses, tuberculous foci, or a small subcapsular or parenchymatous tumour is to be removed, this should be done by making two sloping incisions from the surface and approaching to one another as they approximate the renal cavity—so as to include a wedge-shaped segment of the renal substance. If the cut surface shows signs of disease, slice after slice of fresh renal tissue may be removed, till healthy substance be reached. The cut surfaces should then be brought together by fine aseptic silk sutures—some surgeons prefer catgut.

In other cases small abscesses and tuberculous foci have simply been incised and scraped away, and the raw surfaces treated with a liberal inunction of iodoform emulsion.

In other instances a third or more of the kidney has been cut off by a transverse or oblique incision through the organ, leaving a truncated or flat incised surface, which it is impossible to shut in with sutures. In such cases there is no alternative but to leave the raw surfaces to granulate; but even in these cases it is well to pass through the renal substance a few sutures about a quarter of an inch from the cut surface, by which the wound is compressed and hæmorrhagic oozing restricted, or the edges of the kidney wound may be sutured to the soft parts around. The cut surface has been tamponed in some instances and cauterised in others; but these measures are unnecessary for the control of bleeding, and as they are apt to prevent primary healing they are not, in my opinion, to be recommended.

When the renal capsule is studded with tubercle over as wide an area as the diseased parenchyma, and this is situated at one of the poles of the organ, it may not be possible to make sloping, approximating incisions without sacrificing an unnecessarily large part of the kidney. Wherever possible, however, this should be the direction of the sections, so that as much as possible, if not the whole, of the cut surfaces should be brought into apposition with one another and so retained by well-placed sutures. If, by a little planning, sufficient of the fibrous capsule can be left to be united by sutures over the divided parenchyma, this should be done; but in such a manner as to allow a vent hole for the escape of any blood or urine which may exude. A drainage tube reaching down to the kidney should be inserted in every case, and retained for four or five days, or even longer if, as sometimes happens, urine is discharged from the wound. Unless a calyx is opened up this will not occur; but in cases in which one-third or more of the organ, or a wedge-shaped piece extending into a calyx is removed, the escape of urine by the wound for a period varying from a few days to two or three weeks must be anticipated and provided for. The parietal wound is closed by sutures, and dressed as in cases of nephrolithotomy, nephrotomy, and nephropexy.

DIFFICULTIES AND COMPLICATIONS OF NEPHRECTOMY.

Nephrectomy, whether partial or total, must necessarily be a serious operation, and one which should never be undertaken by a surgeon who is not prepared for any of the emergencies incidental to it.

The dangers and complications of nephrectomy, whether lumbar or abdominal, are both immediate and subsequent. Some of the subsequent complications may occur, no matter what may be the state of the kidney removed; others depend upon whether the kidney is septic or aseptic. The immediate dangers depend almost entirely upon the condition of the kidney and upon the condition of the perinephric tissue.

A. **Immediate dangers and difficulties.**—1. *Those dependent upon the condition of the kidney.*

The removal of a large solid kidney necessarily increases the disturbance of the surrounding parts, and the degree of shock attendant upon the enucleation and removal. A large simple cystic tumour or hydro-nephrosis does not do so, as it can be reduced to very small dimensions before the enucleation is commenced. A large hydro-nephrosis for instance, half filling the abdomen, can be removed through a lumbar incision four inches long, if care is taken to properly expose the fibrous capsule before beginning to detach the perinephric tissue, and if the fluid is drawn off as soon as the proper capsule is reached; then the collapsed cyst is easily drawn by degrees through the wound, as the fibro-fatty tissue is carefully peeled off it with fingers and forceps, aided perhaps here and there by a snip with blunt-pointed scissors, keeping close to the fibrous capsule all the time till the pedicle is reached.

Another difficulty with a large solid tumour, which does not occur with the aseptic cystic tumours, is the extent to which the former may overlap and project far beyond the pedicle, making the pedicle invisible, and almost inaccessible, until the tumour is delivered upon the surface of the body. In some cases the pedicle has to be transfixed and ligatured, the surgeon being guided by touch alone, it being quite impossible to inspect it until the tumour is cut away.

The bulk of the tumour may cause danger by obscuring any bleeding vessels in the perinephric tissue which are torn whilst isolating the kidney. The difficulty and delay in seizing these may lead to considerable loss of blood.

The consistence of the tumour is also a source of difficulty and danger during the operation, and may be also a source of subsequent complications. If a solid new growth is very soft and friable, and the capsule is torn in the process of enucleation, serious, alarming, and even fatal hæmorrhage may occur. The surrounding structures may become infected with the cells of the neoplasm, and the train thus laid for early recurrence.

If the wall of an enlarged septic kidney—a large calculous or tuberculous pyo-nephrosis for instance—is thin and becomes rent, bleeding from the vascular and friable renal substance may be troublesome; and the cellular tissue bed of the kidney will be fouled. If an abdominal operation is being performed, or if the peritoneum is torn during a lumbar operation, the peritoneal cavity may be suffused with the contents of the tumour and septic peritonitis may follow.

With experience of the operation, and care in detaching the adhesions and manipulating the mass to be removed, the surgeon will in the majority of cases, though not in all, be able to avoid lacerating the capsule of a renal new growth and the renal parenchyma, if not also the capsule of a septic nephrectasis.

Great distension of the renal pelvis is another cause of difficulty and danger in certain cases where the kidney and the tissues around it have been inflamed and become sclerosed. Mere dilatation of the renal pelvis, as in cases of hydro-nephrosis, gives no real trouble. It increases by so much the area over which the perinephric tissue has to be separated; but the separation is in these cases generally quite easily accomplished. The dilated flaccid pelvis is readily isolated from the vessels, the vessels tied, and the pelvis traced on into the ureter, which should be ligatured low down and removed in continuity with the kidney. Not so, however, when the renal capsule and its continuous structure the renal pelvis are thickened, toughened, and closely adherent to the sclerosed fibro-fat which invests the whole organ and encroaches into the hilum. In this condition it is often dangerous to attempt and would be impossible to accomplish the task of isolating the widened and tough renal pelvis. The thick tough mass of the pedicle has to be treated as a whole, and transfixed and ligatured in two parts; and when the kidney is cut away the surgeon must be on his guard for the retraction of the pelvis and the slackening of the ligatures on the renal vessels.

This source of danger, however, is really more due to the sclerosis of the fibro-fatty tissue around than to the widened and voluminous state of the renal pelvis itself.

A further source of both difficulty and danger is the upward enlargement of a pyo-nephrosis in a *bombé* manner, stretching the peritoneum, which may tightly adhere to it, displacing the spleen, and encroaching on the diaphragm. No matter whether abdominal or lumbar or the combined operation be performed, this is a real and great danger; the peritoneum is likely not only to be torn, but part of it torn away, the spleen may drop into the wound, and the large pouch of the kidney may be ruptured in the process of being enucleated and its fœtid contents suffuse the cellular tissue and peritoneum.

In addition to and more serious than all these mechanical difficulties is the danger to life by shock, which the great interference with the parts so close to the solar plexus and the diaphragm causes.

The condition of kidney which in my experience has been the source of the greatest danger is rupture or ulceration of a large branch of the renal artery, leading to the formation of blood-clot within the renal cavity (*see* pp. 212 and 213).

This condition should be suspected if, with a history of renal calculus, the kidney has at intervals or on some one occasion increased rapidly in size; or if a renal tumour has formed or increased after an attack of syncope, as in a case I have reported;* or if after an injury attended with hæmaturia, a swelling in the renal region, after remaining stationary for a time, increases rapidly in size, and possibly gives a faint or doubtful pulsation. In such cases, whether the hæmorrhage comes from the patent orifice of a torn artery or from a vessel opened by the eroding effects of a branch of a calculus, the hæmorrhage is very alarming if the kidney happens to be accidentally torn or unintentionally opened in the course of the manipulations for expelling the kidney for diagnostic reasons, or when it is cut into for the purpose of reducing its bulk or extracting the calculus. The only thing to do in these cases is to close the opening in the artery, with the hand inside the kidney, or to compress the aorta until the kidney is sufficiently cleared to allow the pedicle to be ligatured.

2. *Difficulties dependent upon the condition of the perinephric tissue.*

When the perinephric tissue is normal it usually comes off very readily from the kidney, and there is no bleeding to speak of from any vessels torn across in the process of detaching it. It occasionally happens, however, that a large branch of artery or vein runs far away from the hilum over the posterior surface of the kidney, and should this be torn unobserved, and the vessel and the loose cellulo-fatty tissue in which it runs recoil completely towards the spinal column, the bleeding may be very free, and the source of it very difficult to detect under cover of a large tumour not sufficiently isolated to cut away at the very moment. The way to escape this difficulty is to have a free external opening, and to look at all the tissue as far as possible as it is being detached from the renal capsule. Any tense cord or string-like slip of membrane about which there is any doubt, or which offers resistance and cannot be well inspected, should be secured in pressure forceps before being divided. A kidney enlarged by a heavy vascular neoplasm, when partially enucleated, may, if left unsupported for a second, suddenly drag away by its weight, and rupture the vessels of the pedicle either near the hilum, or, what would be still worse, close to the vena cava or aorta. The renal vessels, or the cava itself, have on too many occasions given way and led to fatal hæmorrhage from unnecessary and unjustifiable strain being put on the pedicle in the process of enucleation.

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* *Path. Soc. Trans.*, vol. xxii., p. 171 (1871): "Very large simple cyst of left kidney filled with blood-stained fluid and laminated blood-clot."

It is when the perinephric tissue is hypertrophied, condensed and indurated from long-standing chronic perinephritis that the most frequent difficulties and accidents of the operation occur. They may be grouped under two heads: (*a*) Those arising from adhesions to surrounding structures; (*b*) those arising from condensation and shortening of the pedicle.

(*a*) Attention has been drawn several times in these pages to the fact that the kidney, especially the calculous and tuberculous pyo-nephrotic kidney, is sometimes as it were set in a casing of thick, hard fibro-lipomatous tissue the result of chronic perinephritis. This leads to several evil consequences. It may be most difficult to localise or identify the kidney at all; it may be impossible in old-standing suppuration cases to remove the kidney entire either with or without its proper capsule; cases have been met with in which it was difficult even to dissect the organ away in the post-mortem room. Firm adhesions may thus have been formed with colon and peritoneum and pancreas, and even with the aorta and vena cava. The colon may have to be wounded in more than one place, or a portion of peritoneum may have to be cut away, in order to remove the kidney. Greig Smith ("Abdominal Surgery") mentions a case of large suppurating kidney in which the aorta and vena cava were so adherent to the kidney that it was found impossible at the autopsy to dissect them apart.

(*b*) The pedicle is greatly altered in some cases by the changes which follow chronic perinephritis. The condensed fibro-lipomatous or cellular tissue forms a rigid wall around the vessels, stiffens and fixes the renal pelvis, and extends sometimes far into the hilum and along the intervals between the calyces.

The effect is to harden and shorten the pedicle, and to act like an unbreakable and incompressible solid injection material in expanding the fissure of the kidney and stiffening its contents. So hard and incompressible may the pedicle be that neither clamp forceps nor transfixion ligatures control the arteries, no matter how tightly they may be applied upon the pedicle; and so short may be the interval between the aorta or cava and the renal fissure that there is not room for the application of either forceps or ligature.

To meet the difficulty of *the incompressibility of the pedicle* I have been in the habit of transfixing the pedicle near the hilum with a double ligature of silk and tying it in two halves, leaving the ends of the ligatures long. Between these ligatures and the hilum I surround the whole pedicle with a stout silk ligature, which I tie as tightly as possible, leaving its ends long. As I cut away the kidney, I grip as well as I can the cut end of the stump with my left fingers and thumb, and as soon as the kidney is cut free I pull gently but firmly upon the long ends of the ligatures so as to bring the stump of the pedicle into view, and if any of the vessels in it are bleeding I seize them and tie them individually in separate silk ligatures. The ligature encircling the pedicle can now be removed if desired; the others are cut short before the wound is closed.

If the *renal pelvis is dilated, and its walls rendered incapable of being separated from the rest of the pedicle by its encasement of condensed tissue,* it will pretty surely be transfixed by the ligatures near its centre. It will thus be split in its longitudinal axis in the stump, and if it be septic or tuberculous, the loin cavity will become infected and a fistula will be almost certain to result. The best thing to do in these cases is to dissect away that part of the renal pelvis which projects beyond the ligatures, and if possible to trace the ureter a short way below the renal pelvis, and after securing it in a ligature to dissect off the upper end of the ureter, removing with it as much of the renal pelvis as possible. If the whole of the renal pelvis cannot be removed, what remains should be liberally rubbed over with pure carbolic acid. Should any of the renal pelvis have been drawn out from the embrace of the ligatures, notice must be taken whether the ligatures are at all slackened on the vessels, and, if so, additional ligatures should be applied to the cut end of each of the vessels.

When the *pedicle is very short and tough and the renal sinus has become widened by sclerosed fibro-lipomatous tissue* it is useless and dangerous to try to isolate and ligature the pedicle itself. Instead of attempting to do so, the best course is to transfix the fibro-fatty tissue at the sinus of the kidney and ligature it in segments, tying each segment as tightly as possible and leaving the ends of the ligatures long. The kidney should then be cut away whole or piecemeal, as far as the security of the ligatures will allow. As this is being done the same precaution to compress the cut surfaces between the fingers and thumb of the left hand should be taken as in the case of the pedicle, just mentioned. After the mass of the kidney is thus removed, the long ends of the ligatures serve the purpose before described of bringing the stump into view and holding it there whilst any bleeding vessels in the stump are seized and ligatured. It may, now that the bulk of the kidney is away and a better command and a better view of the pedicle can be had, be found possible to apply transfixing ligatures much further back than before, so that much of the fibro-lipomatous and renal tissues in the stump as at first formed can be trimmed away, and the bleeding vessels, if any, can be seized in pressure forceps and ligatured separately as the trimming process proceeds. All the ligatures should be cut short before closing the wound.

The difficulties arising in lumbar nephrectomy from *a very narrow ilio-costal space*, especially in stout persons, must be overcome by extending the incision downwards and forwards as indicated in Fig. 122 (p. 132, Vol. II.), or by joining the short vertical incision to the oblique incision, and by removing the last and if requisite the eleventh ribs from their free extremities backwards as far as the outer border of the erector spinæ muscle. The surgeon who undertakes to perform nephrectomy ought to be prepared to excise large portions of one or more ribs without opening the pleural cavity; and if he does this when he wants more room to reach and enucleate the upper pole of the kidney he will find that there are very few, if any, cases in which sufficient space is not thus obtainable without his patient subsequently running any risk of lung or pleural complications.

B. **Subsequent complications.**—Shock and hæmorrhage, pulmonary and cardiac embolism, are common to renal and all other large operations.

Uræmia may follow nephrectomy, no matter what the condition of the kidney for which it may be performed.

Both peritonitis and intestinal obstruction are sequels to renal as well as to other operations on the abdomen.

Peritonitis may follow the lumbar as well as the abdominal operation if there has been an accident to the peritoneum. Death from intestinal obstruction has occurred in at least one case after abdominal nephrectomy (Thornton's case).

Septic troubles—suppurative cellulitis, sloughing of the cellular tissue, erysipelas, and empyema—sometimes follow nephrectomy for septic conditions of the kidney.

Fistula is a still later result, and may be caused in calculous cases by the escape of fragments of calculi into the perinephric tissue, keeping up suppuration there; in tuberculous cases, by the persistence of suppuration and the continuance of tuberculous ureteritis; in any case in which septic infection ensues after the operation, whether the kidney itself was septic or not at the time of the nephrectomy.

Sloughing of the cellular tissue sometimes occurs in cases in which suppurative cellulitis follows injury or the irritation kept up by the presence of ligatures or buried sutures.

Another "subsequent complication," and one which is a distinct argument against subcapsular nephrectomy when it can be possibly avoided, is the distension of the renal capsule with blood and exudation fluid. I have recorded in the *Lancet* of January 1, 1898, a case in which, after subcapsular nephrectomy for tuberculous kidney, a large tumour was formed in this way. It was successfully treated by ureterectomy and the removal in continuity with the ureter of the large renal capsule, the distension of which was the cause of the tumour (*see* Fig. 202, p. 630).

Shock may be induced either with or without hæmorrhage. There is, I think, ample reason for believing that many of the deaths which occur within a day or two of a nephrectomy, like the deaths which occur with the same symptoms after hysterectomy and ovariotomy, are due to partial anuria or uræmia, owing to the opposite kidney being the seat of chronic interstitial nephritis, though to the naked eye it may be apparently healthy.

Secondary hæmorrhage is very rare, still it has occurred at varying periods up to the seventeenth day. In one case in the hospital practice of a colleague the ligature slipped a few hours after the patient was returned to bed. What had happened was suspected from the pulse, pallor, and general condition of the patient, together with the fact that the bladder was distended, and blood was being passed by the urethra. The wound was opened up, and the bleeding was found to come from a large branch of the renal artery, the blood escaping down the ureter. The vessel was ligatured, and the case subsequently did well.

In a case in which the secondary hæmorrhage first appeared on the fifteenth day, and recurred on the sixteenth and seventeenth days, it was due doubtless to dragging on the ligatures, the ends of which had been left long. It was subsequently arrested by plugging the wound with two large sponges steeped in perchloride of iron, and swathing the abdomen tightly in a flannel bandage. No bleeding occurred after the plugging, and the patient made a good recovery.*

Pulmonary and cardiac embolism may occur in any kind of case, septic or aseptic, when a normal-sized or very large kidney has been removed. It may occur within two or three days, or not until the fourteenth or fifteenth day or later. It may take place when the wound is healing or has healed by first intention, or when healing by granulations after considerable suppuration. It is more likely to occur in fat, portly, phlegmatic subjects than in others. It is sometimes preceded by great mental anxiety and apprehension, but without any other warning, death occurring with great and even momentary suddenness, or after two or three hours of dyspnœa and much consequent suffering.

Uræmia, when it occurs, is due to a diseased condition of the opposite kidney, which may be of normal size and outline, yet so far involved by chronic interstitial nephritis that it does not respond after the disturbance and depression of a large operation attended with the loss of whatever amount of functional renal substance had still existed in the kidney excised.

In nephrectomy for calculous pyo-nephrosis there is always anxiety lest the opposite organ may be impaired by the same disease. So too with tuberculous disease, though the probabilities of both organs being involved are perhaps not quite so great.

In many cases after renal operations—nephrectomy and others—there is a temporary partial or total suppression of urine (due to a reno-reflex cause) for some hours, followed by the secretion of a very much less quantity than normal for two or three days after the operation. In these latter cases, however, the urine is probably quite normal, and will soon show a daily steady increase in the quantity secreted.

Peritonitis ought not to occur, if all due antiseptic precautions have been taken, if any wound in the peritoneum which may have been accidentally caused is sutured immediately, and if care is taken to keep the peritoneum free from infection in the event of a rupture during the operation of a septic organ; or to cleanse the cavity should there be any escape into it.

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* C. Lucas, *Trans. Intern. Med. Congress, London*, 1884.

Intestinal obstruction is hardly likely to occur except as a result of suturing the ureter or the posterior layer of the peritoneum to the anterior abdominal wound in the course of an abdominal nephrectomy.

Empyema may result by an extension of septic cellulitis from the loin, through the cellular interspace between the muscular fibres of the diaphragm which exist on both sides (costo-diaphragmatic hiatus). I have only known it to occur once, if at all, and that was after nephrotomy for calculous pyonephrosis, which had been performed in the country, by a well-known London surgeon, doubtless under circumstances of much difficulty. Many fragments of calculus were left behind, some of which escaped into the surrounding cellular tissue. Empyema was said to have ensued, and was treated by an intercostal incision between the eighth and ninth ribs three weeks after the nephrotomy. A fistula at this spot, as well as one in the loin, persisted until after several fragments of calculus were removed and portions of four ribs were excised. When I removed the ribs about two years after the nephrotomy, there was no evidence, except the position of the upper fistula, that the pleural cavity had ever been involved, and I thought the suppuration might have been throughout extra-pleural, having tracked upwards from the perinephric tissue through the costo-diaphragmatic hiatus. I have never seen pleurisy or any other thoracic trouble follow excision of the twelfth rib, or the twelfth and eleventh ribs, though I have performed this operation to facilitate renal operations on at least a dozen occasions.

COMPARISON BETWEEN LUMBAR AND ABDOMINAL NEPHRECTOMY.

The abdominal operation is generally credited with having certain distinct advantages over the lumbar, viz.—(1) it enables the surgeon to palpate the opposite kidney; (2) he can come more directly down upon the pedicle and thus secure the renal vessels at an earlier stage in the operation; (3) it affords more room; (4) it permits of the kidney always being identified, which in exceptional cases the lumbar incision does not do; and (5), in cases in which there is any uncertainty whether the tumour is of renal, hepatic or some other origin, it enables this doubt to be cleared away by an intra-peritoneal examination.

The last is a real advantage, but one which need form no part of the nephrectomy. It is but the ordinary laparotomy for diagnostic purposes. I have on several occasions, after having ascertained the renal nature of a doubtful swelling by laparotomy, closed the abdominal wound at once, and then performed an ordinary lumbar nephrectomy. My practice in this matter has, I know, been followed by other surgeons.

Criticism of the supposed advantages of abdominal nephrectomy. —With regard to the other four points, the arguments advanced are more plausible than real, the supposed advantages more theoretical than practical. **First**, as to the palpation of the opposite kidney, it is now well known and universally acknowledged that a kidney which to the touch may be of normal size, outline, and consistence, may be so diseased by nephritis, tubercle, or even calculus, that it is incapable of continuing life after nephrectomy of the other organ. Moreover, intra-abdominal renal palpation is liable to mislead operators very seriously. I have removed an ovarian dermoid from a lady whose abdomen previously had been explored through the right linea semilunaris: the tumour was diagnosed from this examination to be a sarcoma of the right kidney, and was not removed at the time because the left kidney *could not be discovered with the hand in the abdominal cavity.* The prognosis was pronounced hopeless in consequence. Yet the left kidney was present, and movable, and easily detected by a bimanual examination in my consulting room. The removal of the tumour was followed by an uninterrupted recovery, and needless to say the urinary functions are performed quite normally to the present time.

I was present when the kidneys of another patient were palpated through an anterior abdominal opening by an "abdominal surgeon," who is endowed with a large measure of confidence in his tactile capacity. He could detect nothing abnormal about either of them, so the wound was closed; but a lumbar nephrectomy afterwards corroborated the clinical history, and the opinion based thereon—namely, that the trouble was due to a small hydro-nephrotic kidney with wasted pyramids and a dilated pelvis—in fact, to a typical instance of an intermittent hydro-nephrosis.

On the other hand, with the present methods of examination, namely by the cystoscope, the direct illumination by means of

Kelly's tubes, and the analysis of urine taken from each kidney separately by the ureteral catheter, we can obtain evidence not only of the existence of the opposite kidney, but of its functional value as judged by the characters of the urine it secretes.

Secondly, as to the abdominal route leading more directly and more easily to the control of the renal vessels, unfortunately in the cases where this control is of most importance it is not feasible. In very large soft vascular tumours the tumour itself overshadows the pedicle, and the capsule of the kidney is very likely to be torn in seeking the renal vessels. In the traumatic false hæmato-nephrosis upon which I operated the pedicle could not have been ligatured until the contents of the enormous tumour had been at least partly evacuated.

In the contracted and indurated pedicles met with in tuberculous pyo-nephrosis, and in calculous cases with hæmorrhage into the renal cavity, it would be very difficult to control the renal vessels by pressure, and still more difficult to ligate them effectually before enucleating the kidney, for the reasons previously given.

Thirdly, as to the greater space afforded by the abdominal operation, it has already been stated that abundant room even in the most contracted ilio-costal space can be obtained in the retroperitoneal operation if only the surgeon will make a free incision along the lumbo ilio-inguinal line, and when requisite remove the last rib. Indeed, as the surgeon finds when performing nephro-ureterectomy through this incision, manipulation is even more free than through an incision in the linea semilunaris of five or six inches in length, and the reason why I employ the double incision in certain cases is not because of any want of room by the retroperitoneal method, or because I think the risk of ventral hernia is any greater, but because of the risk of weakening the muscular power of the abdominal parietes by so extensive a division of muscular instead of aponeurotic fibres. This risk is obviated by the method of splitting the various muscles parallel with their fibres, as recommended by Greig Smith, McBurney, Abbe, and Mayo Robson (*see* p. 191, Vol. II.).

Fourthly.—Another advantage which has been claimed for the abdominal operation over the lumbar is that by the abdominal the kidney can always be made out, whereas by the lumbar in a few very exceptional cases this has not been found to be possible. It is true that after very prolonged perinephritis or perinephritic suppuration has completely changed the structures around the kidney, and the kidney itself has been greatly altered, atrophied, or sclerosed, it has not been possible to see the kidney through the loin incision, nor to distinguish it by touch with the hand in the wound. It is just possible that in these extreme cases the kidney might have been distinguishable by the hand in the abdomen; but this would have availed nothing, because even in the post-mortem room the kidney in some of these cases could not be dissected away without damage to important structures, and "could not have been removed from the body by any proceeding claiming to be recognised as surgical" (Greig Smith).

The disadvantages of the abdominal method.—Apart from the disputable advantages which have been claimed for it, the abdominal operation has certain disadvantages which are acknowledged by even its few ardent supporters.

In the event of secondary hæmorrhage, the reopening of the abdominal wound and the necessary disturbance of the abdominal viscera to search for and secure the bleeding vessels are attended by considerable shock, and may be followed by serious consequences to the peritoneum and intestine from which the lumbar operation is altogether free.*

If the outer layer of the mesocolon only is divided, there is not much risk of the vitality of the colon being disturbed by the operation itself; but should secondary hæmorrhage occur and blood-clot press upon the lower part of the colon, and the wound have to be reopened, the gut may slough from interference with its blood supply.

The importance of shock cannot be disregarded. Jacobson is "strongly of opinion that, in spite of all recent improvements in abdominal surgery and their success in preventing *peritonitis*, interference with and handling the contents of the peritoneum, save in the shortest and simplest instances, remains on the score of *shock* as grave a thing as ever it was."

Another very cogent reason against abdominal nephrectomy, and in favour of the lumbar method, is that the diagnosis of the condition of the kidney cannot in all cases be so precise that the surgeon can determine until he cuts down upon, and often indeed until he cuts into, the kidney whether it will be necessary, or in the patient's best interest, to remove the kidney or not. By the lumbar incision nephrotomy or nephrotresis and good drainage can safely be substituted for nephrectomy, whereas these procedures by the trans-peritoneal route are admittedly so dangerous that they are well nigh, if not completely, abandoned.

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* *See* case by Page of Newcastle, *Lancet*, vol. ii., p. 87 (1893).

Allowing for the immunity from peritonitis which the improved methods of modern surgery secure when operating for aseptic conditions, there is nevertheless the risk of septic infection of the peritoneum, even when every precaution is taken against it, when nephrectomy is performed for calculous and other forms of pyo-nephrosis, for tuberculous conditions, and especially when septic fistulæ exist or suppurating tracts burrow in the perinephric tissue. The peritoneum may likewise be contaminated when a kidney, transformed into a soft malignant growth, is lacerated during the process of enucleating it from its surroundings.

There is more difficulty in dealing with the dense adhesions between the back of the kidney and the lumbar parietes; it is during the forward dragging and traction exercised on the tumour whilst these connections are being separated that the greatest catastrophes have happened, and the renal vessels and the vena cava—and even the aorta—lacerated. Drainage cannot be so efficiently provided as by the lumbar incision (*see* remarks on Terrier's operation, p. 249, Vol. II.). There is a much greater risk of ventral hernia than by the ordinary lumbar incision, although the latter cannot claim an absolute immunity in this respect, exceptional though it be for the lumbar scar to yield.

When the lumbar operation is to be preferred.—The lumbar operation ought to be chosen in all cases except (1) for tumours of very large dimensions; (2) after accidents, when it cannot be told without cœliotomy whether or not the injury involves other organs besides the kidney; and (3) in those rare cases of disease of a floating or misplaced kidney requiring nephrectomy. The lumbar operation ought not to be regarded merely as the operation of choice; with the exceptions stated, it is the only operation which ought to be considered justifiable. The kidney, as an extra-peritoneal organ, ought to be attacked from behind, and not across the peritoneal cavity.

When the abdominal operation is to be preferred.—It is only when the kidney assumes intra-peritoneal importance or relations that the trans-peritoneal operation becomes justifiable, *e.g.* when its development in size causes it to occupy a large part of the abdomen and to make prominent the anterior abdominal parietes; when a floating kidney is hydro-nephrotic or pyo-nephrotic, or tuberculous, and is covered posteriorly by peritoneum, or so falls away from its retroperitoneal position that it is like an organ loose within the abdomen; or when after injury other organs as well as the kidney may be damaged; or the peritoneum covering the kidney, as well as the kidney itself, may be ruptured and blood be escaping into the peritoneal sac.

Reasons for preferring the combined lumbar and abdominal operation to the anterior abdominal operation.—In the cases of renal tumours in which cœliotomy is indicated I prefer the combined incision, lumbar first and abdominal afterwards, for the following reasons. By the first or lumbar stage of the operation two things are accomplished before the peritoneal cavity is opened, viz. (1) the exact condition of the kidney, and the necessity of proceeding to nephrectomy rather than limiting the operation to nephrotomy or nephrotresis is decided upon; and (2) all the posterior adhesions and connections of the kidney are detached without any forcible traction or forward dragging being exercised upon the kidney or the renal pedicle; in this way the risk is avoided of tearing the large vessels—a risk which is so great if the posterior adhesions are being separated whilst the tumour is dragged forwards, towards or into the anterior abdominal wound.

The other advantages of the combined incisions are that it facilitates the delivery of the kidney through the anterior abdominal incision by enabling the surgeon or his assistant with a hand in the loin wound to support or gently push the organ forwards during the act of delivering it; and by affording a channel of perfect drainage it allows the peritoneal cavity to be practically shut off from the areolar tissue space within a few hours after the operation, owing to the natural tendency to rapid union of the divided edges of the posterior peritoneal incision.

When for diagnostic purposes it is desirable to make the cœliotomy the first stage of the operation, the division of the mesocolon and the enucleation in front should be postponed until after the posterior enucleation through the lumbar incision is completed.

In cases of primary nephrectomy for injury, and in nephrectomy for diseased floating or misplaced kidney, when the transperitoneal nephrectomy is indicated, the lumbar incision is only required, if at all, for drainage.

I would especially point out that the renal tumours of large dimensions for which an abdominal incision is requisite or advantageous are only the solid neoplasms. I especially exclude hydronephrosis and large simple cysts, no matter to what size they have attained, even to filling three-quarters of the abdomen. No cases are more suitable to the lumbar operation than these large thin cysts. If the directions which I have given on p. 260, Vol. II., are followed, most of these cysts can be removed through the loin with the same ease that a simple ovarian cystoma with a few slight and recent adhesions is removed through an incision in the linea alba.

RESULTS AND CAUSES OF DEATH AFTER NEPHRECTOMY.

The causes of death have been already incidentally referred to when describing the subsequent complications of the operation. They are shock, hæmorrhage, pulmonary and cardiac embolism, uræmia and suppression of urine, peritonitis, and various septic conditions.

Other rare cases of death are intestinal obstruction, empyema, secondary hæmorrhage, and exhaustion from prolonged suppuration in the cellular tissue of the loin; suppuration may extend into the iliac fossa and the true pelvis and lead to multiple discharging sinuses in the loin, groin, and front and lateral parts of the abdominal wall.

The immediate results of nephrectomy, so far as life is concerned, vary, as one would expect them to do, with the disease or injury for which the operation is performed.

Tuffier's tables, published in September, 1899, give the results in 361 operations as follows: 200 lumbar nephrectomies with a mortality of 28·4 per cent., and 161 trans-peritoneal nephrectomies with a mortality of 44·1 per cent.

The minimum mortality of the lumbar operations was in the case of tumours and hydro-nephrosis, namely about 24 per cent.; the maximum was in the case of various suppurative conditions for which it was performed, and was 36 per cent. In tuberculous disease the death rate was 28 per cent.

In trans-peritoneal nephrectomy the lowest mortality was in the operations for hydro-nephrosis, cysts, and other aseptic collections, for which it stands at 32 per cent. The highest mortality was for tumours, for which the death rate is shown to be 59 per cent. In the suppurative conditions abdominal nephrectomy gave 43 per cent., and in operations for tubercle 36·3 per cent. mortality.

Tuffier's actual figures of the number of operations and the mortality for each class are as follows:—

LUMBAR NEPHRECTOMIES.	TRANS-PERITONEAL NEPHRECTOMIES.
112 Suppurative (51 calculous pyelitis, 71 pyelitis non-calculous), 35·9 per cent.	35 Suppurative (16 calculous pyelitis, 19 non-calculous pyelitis), 43·2 per cent.
21 Aseptic collections (16 hydronephrosis, 5 cysts), 23·9 per cent.	49 Aseptic collections (25 hydronephrosis, 24 cysts), 32·4 per cent.
21 Tumours, 24·2 per cent.	66 Tumours, 59 per cent.
46 Tuberculous kidneys, 28·2 per cent.	11 Tuberculous kidney, 36·3 per cent.

Tuffier gives the mortality in thirty-six cases of secondary nephrectomy at 9·2 per cent. on the whole number, and at the following rates in the different conditions named:—

25 Suppurative cases, 8 calculous pyelitis, 17 non-calculous pyelitis	11·9 per cent.
3 Aseptic collections (hydro-nephrosis) . .	No deaths.
8 Tuberculous kidneys	25 per cent.

The mortality after nephrectomy in my own practice up to March, 1900, is shown by the following table:—

29 Nephrectomies for calculous disease, of which 24 recovered and 5 died, giving a mortality of	17·24 per cent.
24 Nephrectomies for nephrectasis (hydro- and pyo-nephrosis) including two cases in which there was acute general pyelonephritis. Of these 21 recovered and 3 died, giving a mortality of . . .	12·5 per cent.
22 Nephrectomies (excluding 6 nephro-ureterectomies) for tuberculosis, with 17 recoveries and 5 deaths, giving a mortality of	22·7 per cent.
17 Nephrectomies for tumour (of which one was in an infant 9 months old, who died within an hour from shock), with 13 recoveries and 4 deaths, *i.e.*, a mortality of	23·5 per cent.
3 Nephrectomies for fistula, without a death.	

In one case, not included in any of the above groups, a lady aged forty-one, who had a secondary fistula following nephropexy performed fourteen months before, underwent nephrectomy for acute nephritis when in a very septic state and as *un dernier ressort* a few weeks after a confinement. The operation failed to benefit her and she died on the following day; but the operation in no way hastened her death.

All the cases of nephro-ureterectomy recovered from the operation. Details respecting ten cases of partial nephrectomy, in seven of which the operations were for tuberculous diseases, are given on p. 257, Vol. II.

PART II.—SURGICAL DISEASES OF THE URETER.

CHAPTER I.

ANATOMY AND SURGICAL ANATOMY.

THE ureters are moderately thick-walled ducts, which extend from the kidneys to the base of the bladder.

Course and curves.—Commencing at the termination of the renal pelvis, at a point to the inner side of and somewhat above the lower extremity of the kidney, the ureter descends through the abdomen on the surface of the psoas muscle to the pelvic brim, where it crosses the lower end of the common or the upper end of the external iliac artery and turns abruptly backwards and outwards on the side wall of the pelvis to a point about an inch in front of the spine of the ischium, thence it passes forwards and inwards on the upper surface of the levator ani to its termination in the base of the bladder.

In the abdominal part of its course the ureter forms a slight curve with the convexity directed forwards and inwards, and in the pelvis it makes a second greater curve, the concavity of which is directed forwards, inwards and upwards. The abdominal and pelvic portions join each other at the pelvic brim at an angle of 135° (Schwalbe), which is salient forwards.

Length.—The average length of the ureter is about 30 cm. (12 inches), but it varies, with the stature, from 25 to 38 cm. (10 to 15 inches), and the left ureter is slightly longer than the right on account of the higher position of the left kidney.

Diameter.—The diameter of the tube is not uniform; on the contrary, it presents three contractions and two intermediate dilatations. The first contraction, called the "Superior isthmus," is situated about 7 cm. ($2\frac{1}{2}$ inches) below the hilum of the kidney, and in this situation the diameter of the tube is 3·2 mm. It is the narrowest part of the ureter. The second contraction, called the "Inferior isthmus," is at the angular bend at the brim

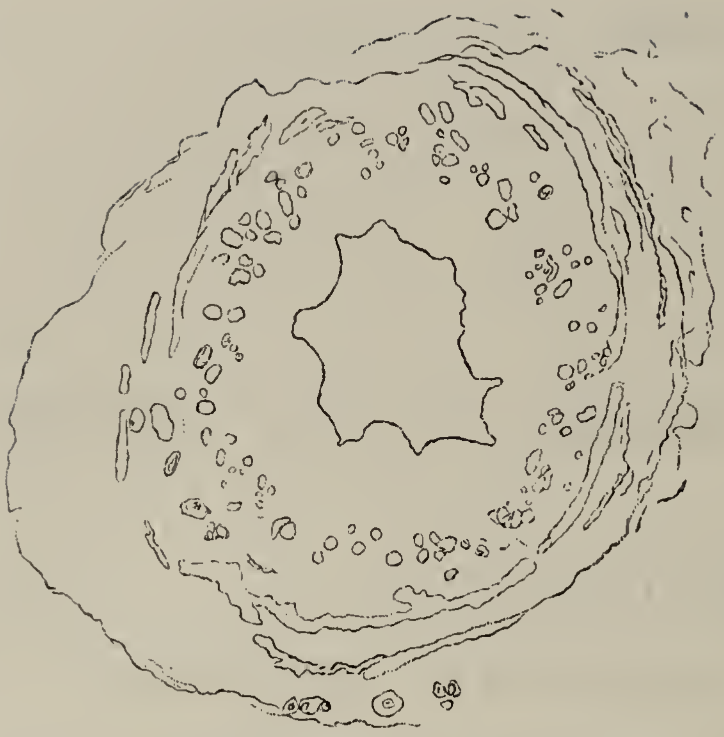

Fig. 130.—Section of lower part of Pelvis, just above Ureter.

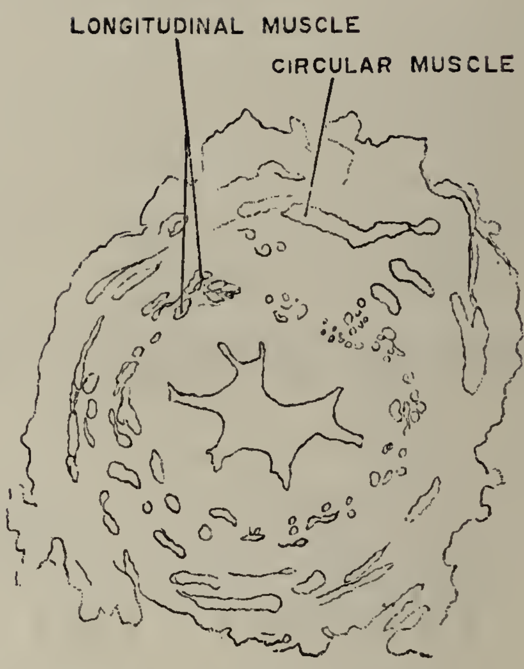

Fig. 131.—Section through commencement of Ureter.

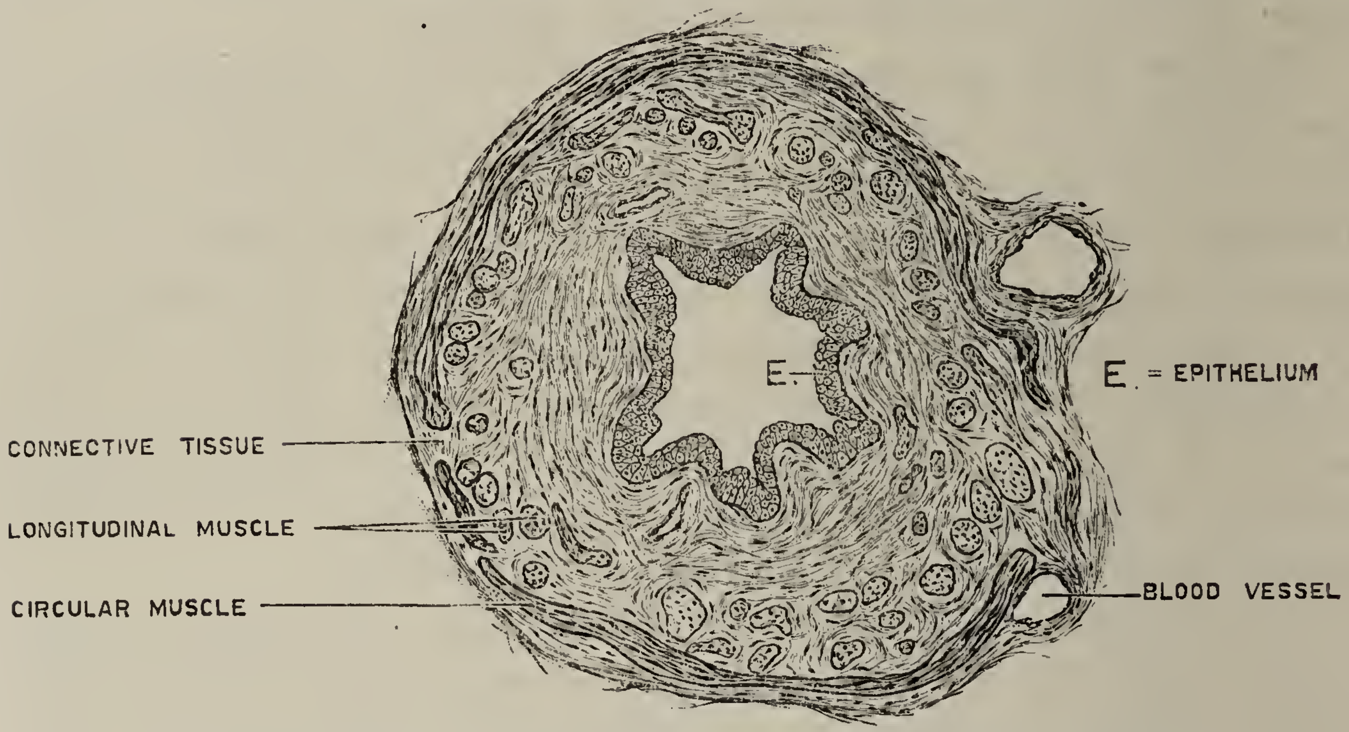

Fig. 132.—Section of Isthmus of an adult below Upper Spindle.

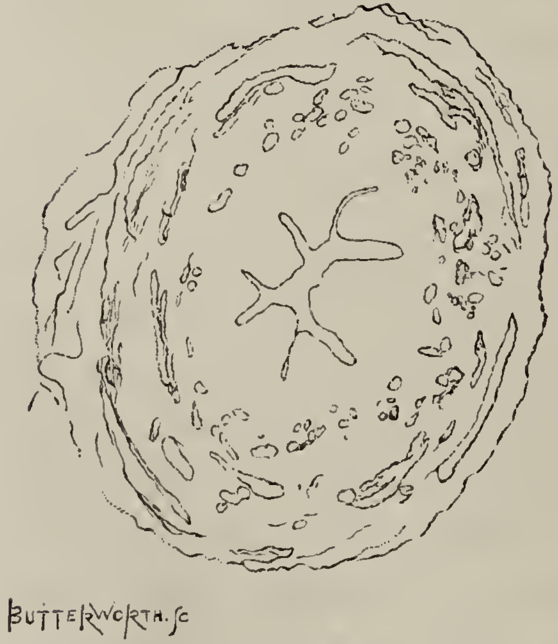

Fig. 133.—Section of Ureter, just above Upper Spindle.

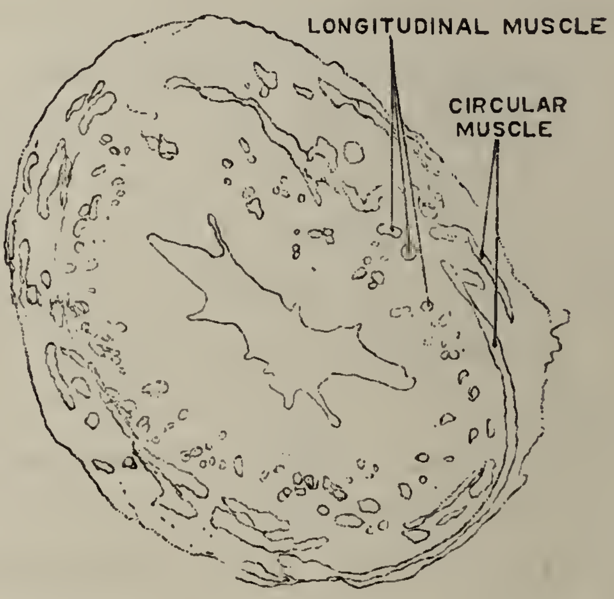

Fig. 134. — Section of Ureter, through Upper Spindle.

The above figures are from drawings made by Professor Arthur Robinson of sections prepared by himself.

of the pelvis, where the diameter is 4 mm., and the third contraction is at its termination in the bladder wall. The two dilatations which lie between the three contractions are frequently called the upper and the lower spindles; the former lies in the abdomen and is fairly uniform in contour—its diameter is 8 mm. in the right and 7 mm. in the left ureter. The lower dilatation is very irregular, and is frequently very little marked.

Structure.—The walls of the ureter consist of three coats, fibrous, muscular, and mucous (*see* Figs. 130–134).

1. The thin external fibrous coat contains a large quantity of elastic tissue; it is continuous above with the fibrous capsule of the kidney, below with the fibrous layer of the bladder wall, and it is intimately connected in the abdominal portion of its extent to the peritoneum which covers it in front, and which is here very thin and runs great risk of being torn in any attempt to separate it from the ureter. In the pelvis the connection is much less intimate, as a quantity of fatty tissue separates the peritoneum from the ureter.

2. The middle or muscular coat consists of plain muscular fibres arranged in the greater part of the length of the tube in two layers, an inner layer of longitudinal fibres grouped in bundles, and an outer layer of circular fibres (Fig. 132), but the two layers are not absolutely distinct from each other, for groups of fibres which are longitudinal at one level bend outwards and become continuous with the circular fibres at a higher or a lower point; obviously, therefore, many of the bundles are spirally curved and they form at one part of their course a portion of the inner muscular layer, and at another a part of the outer layer.

In the lower third of the tube it is sometimes possible to recognise a third muscular layer placed outside the circular fibres and consisting of longitudinal fibres. At the upper extremity of the ureter the fibres of the muscular layer pass into the renal pelvis and into the walls of the calyces, and the inner or longitudinal fibres are continued for a short distance into the substance of the kidney, but the outer circular fibres terminate where the calyces embrace the apices of the papillæ, forming the annular muscle of the papillæ (Henle). At the lower extremities of the ureters the circular fibres blend with the outer muscular fibres of the bladder wall, and the longitudinal fibres arrange themselves in two bands, an upper and a lower; the upper turns towards the middle line, beneath the mucous membrane, and blends with its fellow of the opposite side, taking part in the formation of an inter-ureteric band of fibro-muscular tissue called Mercier's bar; the lower passes downwards and inwards towards the orifice of the urethra, blends below with the substance of the middle lobe of the prostate and forms part of a muscular band (Bell's muscle), to which Bell ascribed the function of maintaining the obliquity of the ureter in the bladder wall during the contraction of the viscus. The muscular coat is the thickest of the three coats of the ureter and it is relatively thickest at the upper isthmus.

3. The mucous membrane is thin and smooth and, on account of the laxity of its connection with the surrounding muscular coat, it is plicated or thrown into transverse and longitudinal folds, when the tube is not distended. It consists of a layer of stratified transitional epithelium supported upon a basis of areolar sub-mucous tissue by which it is loosely connected with the muscular coat. It is continuous above with the mucous lining of the pelvis of the kidney, and below with the mucous membrane of the bladder.

Hamburger is of the opinion "that the upper layer of the epithelium of the ureters possesses a homogeneous cuticular border. The regeneration of this epithelium probably takes place from the connective tissue cells, the prolongations of the epithelium passing downwards into the connective tissue. Under the epithelium there is a layer of adenoid tissue, more or less developed, and in the case of man there are also scattered lymph follicles."

Wendt has described a few mucous glands scattered here and there in the mucous membrane, especially in the upper part of the tube, and Hamburger states that in the human subject they resemble small sebaceous follicles whose spaces are entirely filled with cells. They are, however, not regularly present in the human ureter, nevertheless in some few cases they become enlarged and form mucous cysts.

The mucous coat is not more than half as thick as the muscular, and it is said to be thinnest at the upper isthmus, where the muscular is thickest (Liaudet).

Relations to each other. — At their upper extremities, where they are continuous with the renal pelves, the ureters are from 9 to 11 cm. (3½—4½ inches) apart in women, and from 8½—11 cm. apart in men; converging as they descend in the abdomen, they are separated from each other at the level of the highest points of the iliac crests by a distance of 7 cm. (2⅘ inches) (Liaudet). At the pelvic brim the distance between them is from 6¾—8½ cm. (2½—3½ inches). From this point they diverge following the lateral curves of the pelvic wall until about 3 cm. (1⅕ inches) below the brim and immediately above the obliterated hypogastric arteries, where they are from 9—10 cm. (4 inches) apart. As they run forwards and inwards from the pelvic wall they cross the lateral fornices of the vagina and lie obliquely at the sides and in front of the cervix uteri, from which they are separated by a distance of from 1·25 to 1·85 cm. (½ to ¾ of an inch), and whilst in this situation they are separated from each other by a distance of from 6—7 cm. (2½ inches). They enter the walls of the bladder from 3½—4½ cm. apart (1½—1¾ inches), and in the female 6 mm. (¼ of an inch) below the upper end of the anterior wall of the vagina. After passing obliquely through the wall of the bladder they open into its cavity, when the viscus is empty, from 19—25 mm. (¾—1 inch) apart, and their vesical orifices are connected with each other, as just stated, by a band of fibro-muscular tissue, Mercier's bar, which sometimes projects forwards into the cavity of the viscus.

The distance from the vesical orifice of each ureter to the urethral opening of the bladder, in the undistended organ, is from 2½ to 3 cm. (1—1⅕ inch) and the terminal portions of the ureters are connected to the neck of the bladder by the band of muscle fibres described by Bell.

In the female the distance from the entrance of the ureter into the empty bladder to the orifice of the urethra is from 4 to 5 cm. (1⅗—2 inches).

Relations to adjacent structures.—The ureter has but a very loose connection by means of cellular tissue with the parts on which it rests.

In *the abdominal portion* of its extent it lies upon the front of the psoas muscle, and about half-way between its commencement and the brim of the pelvis, or somewhere below that point, it crosses in front of the genito-crural nerve. The upper half of this portion of the duct, except at its commencement on the right side where it is covered by the third part of the duodenum, is in direct contact with the peritoneum, to which it is intimately connected; and the lower half is separated from the peritoneum by the spermatic or ovarian vessels, which are, however, closely united both to the ureter and to the serous membrane. These vessels come into contact with the ureter a little below the level of the highest points of the iliac crests. On the left side the abdominal portion of the ureter is crossed anteriorly by the left colic and the sigmoid branches of the inferior mesenteric artery, and on the right side by the right colic and ileo-colic branches of the superior mesenteric artery. The peritoneum separates it from coils of the small intestine, principally coils of the jejunum on the left and of the ileum on the right.

Occasionally when the large gut is distended the inner border of the colon (ascending or descending according to the side) overlaps the front of the ureter; and on the right side, if the vermiform appendix passes upwards and inwards, it crosses in front of the lower part of the abdominal portion of the right ureter.

At the brim of the pelvis the relation of the ureter to the large vessels is not always quite the same, as it may rest either upon the lower end of the common iliac artery, or upon the external iliac; it is covered in front by the peritoneum, and it is crossed on the right side by the termination of the ileum, and on the left by the commencement of the rectum.

In the pelvis, though several of the relations are the same in both sexes, yet there are so many differences that it is convenient to describe the male and female separately.

In **the male,** after crossing the pelvic brim the ureter passes downwards and backwards along the side wall of the pelvis to a point about one inch to one inch and a half (25—37 mm.) in front of the spine of the ischium; in this part of its course it is immediately in front of the internal iliac artery, externally it is in contact with the parietal layer of the pelvic fascia covering the obturator internus, and it crosses the obliterated hypogastric artery and the obturator vessels and nerve almost at right angles and on their inner sides. Internally it is covered by the peritoneum which separates it from the sigmoid flexure of the colon on the left and from the terminal portion of the ileum on the right. The spermatic artery has no relation with the pelvic portion of the ureter.

In *the second portion of the pelvic part* of its course the ureter runs forwards and inwards from the side wall of the pelvis to the base of the bladder, lying upon the upper surface of the levator ani and beneath the peritoneum, which forms the posterior part of the lateral false ligament of the bladder, and it lies against the side and base of the bladder below the level of the obliterated hypogastric artery. Before it reaches the bladder it is crossed in front by the vas deferens, which passes between it and the side wall of the bladder, and it enters the bladder wall immediately in front of the upper end of the seminal vesicle (*see* Plate II., Chapter I., Vol. I.).

In **the female** also the pelvic portion of the ureter may be looked upon as consisting of two parts, an upper and a lower. The *upper part* passes as in the male from the brim downwards and backwards on the lateral wall of the pelvis to a point from one inch to one inch and a half in front of the ischial spine; externally it is in relation with the parietal layer of the pelvic fascia, the obturator artery and nerve, and the obliterated hypogastric artery; internally it is covered by the peritoneum, which separates it from the sigmoid flexure on the left and from the terminal part of the ileum on the right. Posteriorly it rests against the internal iliac artery. Anteriorly, for a short distance below the pelvic brim, it is accompanied by the ovarian vessels, which, however, soon leave it as they pass forwards and downwards in the upper border of the broad ligament, and then it is in relation with the posterior border of the ovary.

The *second part* runs forwards and inwards upon the upper surface of the levator ani and beneath the base of the broad ligament to the base of the bladder. It is accompanied by a dense plexus of veins derived from the lower part of the uterine and from the upper part of the vaginal plexuses. It crosses below and behind the uterine artery, passes at the side and in front of the cervix uteri and the lateral fornix of the vagina, and enters the base of the bladder at a point in the undistended state about three-quarters of an inch (22 mm.) from the middle line and a quarter of an inch (6 mm.) below the anterior fornix.

The course of the ureter through the wall of the bladder in both sexes is obliquely downwards and inwards for a distance of about 18 mm. ($\frac{3}{4}$ of an inch). In this course it is nearer the inner than the outer surface of the bladder, the muscular coat being posterior to it nearly throughout its length. This portion, with the exceptions of the upper and lower orifices, is the narrowest part of the ureter.

The vesical orifice is slit-like, with its long axis backwards and outwards; it is situated frequently on the summit of a slight elevation, and is from $\frac{3}{4}$ of an inch to 1 inch from its fellow, and about the same distance, or a little less, from the orifice of the urethra. The mucous membrane at the orifice forms a kind of valve. Between the orifices is seen on the inner surface of the bladder the slight elevation or ridge which, as described previously, is formed partly by a band of the longitudinal muscular fibres of the ureter, partly by the muscular fibres of the bladder, and which constitutes what is sometimes spoken of as the inter-ureteric ligament and sometimes as the inter-ureteric muscle of Mercier's bar. This ridge forms the base of the trigone of the bladder; in the male it rests upon the anterior portion of the seminal vesicles and in the female upon the upper third of the anterior wall of the vagina.

The arterial supply.—The arteries which supply the ureter are branches of the renal, the spermatic or ovarian, and the vesical; they anastomose freely together in the walls of the ureter, and the blood is returned by corresponding veins.

The lymphatics.—The lymphatic vessels are numerous; those from the lower part of the tube terminate in the iliac glands, and those from the upper part in the lumbar glands.

The nerves.—The ureter is richly supplied with nerves, which are derived from the renal, the spermatic or ovarian, and the vesical plexuses.

Physiology.—The function of the ureter is that of a duct transmitting the renal secretion to the bladder. It is both contractile and dilatable; contractile on account of its muscular coat, and dilatable and capable of considerable elongation on account of the elastic fibres in its external fibrous coat, the mucous coat being folded in the undistended condition, and therefore capable of extension. The urine is conveyed to the bladder by means of two forces: (1) the force of gravity acting in the erect posture; and (2) the peristaltic contraction of the walls of the ureter; this movement affects the whole length of the duct, and proceeds from above downwards at the rate of from 20 to 30 mm. per second.

Regurgitation of urine from the bladder is prevented under ordinary circumstances by the valve-like nature of the vesical opening. This object is effected by the mucous membrane forming a kind of valve, the terminal portion of the ureter passing obliquely through the bladder wall, and the obliquity of the opening being maintained during the contraction of the viscus by the fibres of Bell's muscle, which connects the lower end of the ureter with the middle lobe of the prostate (p. 280).

As mentioned already, the course of the ureter through the bladder wall is such that the muscular coats of the bladder are on the outer aspect of the ureter, and only the mucous membrane separates the internal wall from the vesical cavity. This is an important fact, and explains how it is that the mucous membrane of the bladder over the intra-parietal part of the ureter wall can be incised for the purpose of abstracting a calculus without running any great risk of opening the cellular tissue of the pelvis.

Clinical considerations. — The ureter commences opposite the body of the second lumbar vertebra, and the position of its origin may be indicated on the posterior surface of the body by a point situated from 4½ to 5½ cm. from the middle line, on a level with the upper border of the second lumbar spine. It is more difficult to localise the relation of the point of origin to the anterior surface of the body; but it may be approximately indicated by a point placed from 4½ to 5½ cm. from the mesial plane on a line drawn round the body about one inch (2½ cm.) below the mid-distance between the upper border of the manubrium sterni and the upper border of the symphysis pubis.

The commencement of the ureter, and at the same time the lower extremity of the kidney and the level of origin of the spermatic or ovarian artery, are all approximately defined by Tourneur's point, which is situated at the intersection of a transverse line between the tips of the twelfth rib, with a vertical line drawn upwards from the junction of the inner and middle thirds of Poupart's ligament.

Halle's point, which is situated at the intersection of a line drawn between the anterior superior spines of the ilia, and a vertical line projected upwards from the spine of the pubis, has been used to indicate the crossing of the ureter over the iliac artery. In some cases this is a fairly correct guide, but usually it is too low and too far inwards; indeed, the point at which the ureter crosses the iliac artery is variable. *For practical purposes, a point lying at the junction of the upper and middle thirds of the line indicating the course of the common and external iliac arteries will sufficiently indicate its position.* The line marking the course of the iliac vessels is drawn from the bifurcation of the aorta, half an inch below and to the left of the umbilicus (or from a point a little to the left of the median plane, in a line drawn round the body at the level of the highest points of the iliac crests), to midway between the anterior superior spine of the ilium and the symphysis pubis.

The terminal portion of the ureter is readily investigated in the female from the lateral and anterior fornices of the vagina; and in the male, though less readily, from the rectum.

The contractions in the calibre of the ureter, pointed out by Halle and Tanquary, Schwalbe and Bruce Clarke, which are situated (*a*) from 63 to 70 mm. ($2\frac{1}{2}$ to 3 inches) below the hilum; (*b*) at the brim of the pelvis; and (*c*) at the entrance into the bladder wall, are of clinical importance in connection with the lodgment of renal calculus. Calculi have often been found impacted in these situations.

The close adhesion of the abdominal portion of the ureter to the peritoneum which covers its anterior surface, to which attention was drawn especially by M. Gigon in 1856,* and again by Sir Philip Crampton,† Twynam,‡ Cabot, and Liaudet accounts for the ureter being carried forwards in all extra-peritoneal extravasations; and for the same reason it is pushed forwards, with the serous membrane, during the course of extra-peritoneal operations in the loin. At the pelvic brim, and in the pelvic cavity, the ureter is surrounded by much loose areolar tissue, and is quite movable beneath the peritoneum.

In the upper part of the pelvis, where it lies against the pelvic wall, the ureter may be pressed upon by aneurysms of the iliac vessels, by fæcal accumulations in the gut, by tumours of the ovary, uterus, or Fallopian tube; and in those cases in which the vermiform appendix descends into the pelvis, the right ureter may be implicated in a perityphlitic inflammation.

In the female, the close relation of the ureter to the lateral fornix of the vagina, and to the neck of the uterus (p. 283), renders it a source of danger in operations on the lower part of the uterus; but if the uterus is pulled upwards and forwards in intra-abdominal operations, or downwards and backwards in vaginal operations, the distance between the cervix and the ureter is considerably increased.

There is a venous plexus intimately binding the ureter to the uterus, and if the artery and the large uterine veins pass on the front of the ureter, other veins pass behind it, so that the tube is embraced and, in a way, immobilised by a vascular network. From the bladder upwards to where the ureter is crossed by the large uterine veins, the ureter is surrounded by a veritable plexus of vesical veins, which ascend along it, interlacing together, to empty themselves into the uterine veins. Poirier* thinks that these peri-ureteral veins bleed when the anterior face of the broad ligament is detached with the index finger, and that it is when placing forceps upon them that the ureter gets nipped and compressed. Segond admits that the anatomy is correct, but denies the occurrence of the hæmorrhage, and says that the vessels do not need forceps, but that the hæmorrhage stops with the pressure of a sponge, and certainly it will do so as soon as the uterus is pulled down.

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* *L'Union Médicale*, Février, 1856.

† *Med.-Chir. Trans.*, vol. xvi., p. 162.

‡ *Clin. Soc. Trans.*, vol. xxiii., 1890.

As a result of obstruction in the lower part of the urinary tract, or of direct pressure upon its lower part, the upper portion of the ureter may be distended to the size of the small intestine, and if it is excited to excessive contraction by the passage of calculi, or clots of blood or mucus, violent colic is induced; this is accounted for by the rich supply of nerves, in connection with which it should be remembered that Charcot has demonstrated the possession of a reflex sensibility by the ureter, and has described a cerebral excitation provoked immediately on the application of a ligature to it; and Barker has shown that a marked effect is sometimes produced on the pulse when a ligature is applied to the pelvis of the kidney.

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* *Bull. et Mém. de la Société de Chir.*, tome xxi., p. 285.

CHAPTER II.

ABNORMALITIES OF THE URETER.

Ureteral abnormalities are often met with, and their frequency is probably explained by the modification which the duct undergoes during development.

In some instances the **absence of a hilum** seems to have been the chief deformity. Durham* recorded a case in 1861 of double ureter to the right kidney. There was no distinct hilum, but the blood-vessels and ureters came off from the anterior and lower part of the kidney. The kidney was small and misplaced, and adherent to the diaphragm by dense fibrous tissue. Newman gives a case in which the right kidney was situated half an inch to the right of the promontory of the sacrum, and the left in the iliac fossa. The right kidney was small and so altered in form that there was no hilum, and the ureter passed from the lower aspect of the organ. The tissue of the organ was normal. The arteries, two in number, came off from the aorta an inch above its bifurcation. The left kidney was normal in every respect except as to its situation.

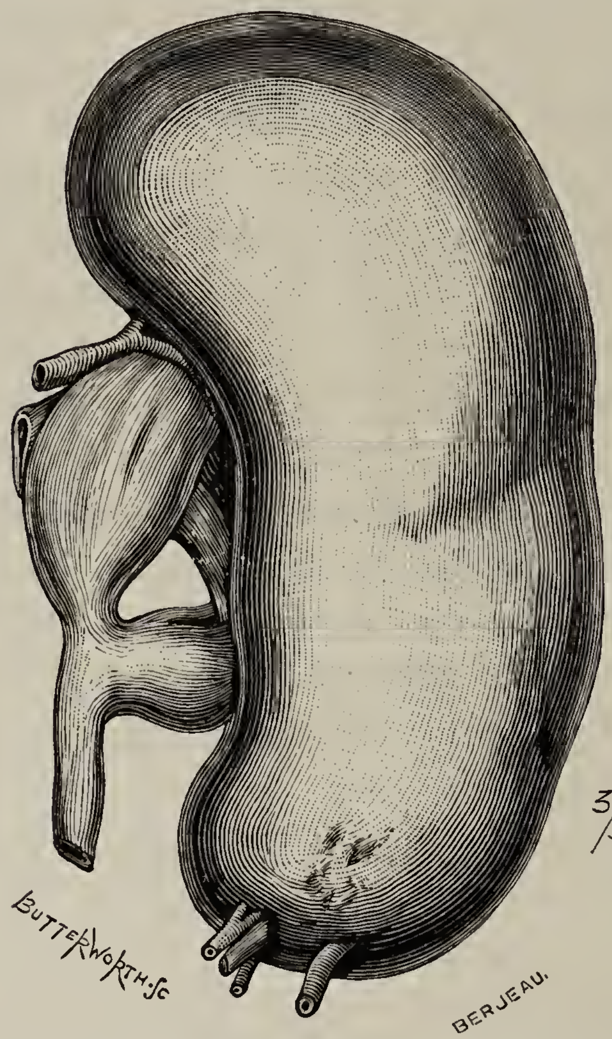

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Fig. 135.—Right Kidney with Double Pelvis. (St. Thomas's Hospital Museum, No. 2067.)

Double renal pelvis is one of the commonest variations found in connection with the ureter; the extent of the division usually varies from half an inch to two or more inches in length, or each may be continued into a separate ureter. A man, aged forty-six, died from hernia reduced *en masse;* his right kidney was of elongated shape, and had two pelves which united into one ureter. The testicle, on the same side as the hernia, was undescended (Guy's Hospital, 1877, No. 309). Two somewhat similar cases are recorded in the *Transactions* of the Pathological Society of London.* In the first, reported by Sir Henry Thompson, only one kidney was affected. It came from a man, aged ninety-six, who died after an impacted fracture of the neck of the femur. The kidney was rather under than over the natural size, but it gave a slight indication of having a natural division into an upper and lower portion. Two pelves were attached, the cavities of which did not communicate with one another. Of these, the lower was very much the larger, and formed a trumpet-shaped sac; the dilatation apparently resulted from a narrowing of the ureter just below. The upper pelvis, small and tubular, became of natural size at a distance of three and a half inches from its hilum; and an inch below this point, *i.e.* four and a half inches from the kidney, both ureters joined to form a single tube of the normal size, which entered the bladder at the usual spot.

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* *Path. Soc. Trans.*, vol. xii., p. 135.

In the interesting case reported by Mr. John Wood † the pelvis of the left kidney was represented by two distinct mucous cavities, each of which was continued into a separate ureter, the condition therefore forming a link between an ordinary single pelvis and two completely separated ones. The ureters in this case issued respectively from the upper and lower ends of the pelvis; they were rather less than normal in size, and united about one inch from the bladder, into which they entered as one tube in the usual situation. In the right kidney of the same subject (a girl aged ten) there were two separate pelves and ureters; the upper one, communicating with a sacculated or cystic part of the kidney, opened separately into the bladder by the side of the uvula vesicæ, close to the exit of the urethra. This case has already been referred to in the section on Hydronephrosis (Vol. I., p. 412).

Double ureter.—The ureter is frequently double at its upper part, but a complete division of the duct, together with a double pelvis, is much less often found, and it is distinctly rare to find a double ureter on each side. Sometimes the renal pelvis is divided into three or four separate partitions, which join together a short distance below the hilum, as is illustrated in Fig. 45 (p. 396, Vol. I.).

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* Vol. vi., p. 642, case 23; and vol. xxxi., p. 188.

† *Ibid.*, vol. vii., p. 261, case 12.

In Dr. Ramsay's case, from which Figs. 136 and 137 are

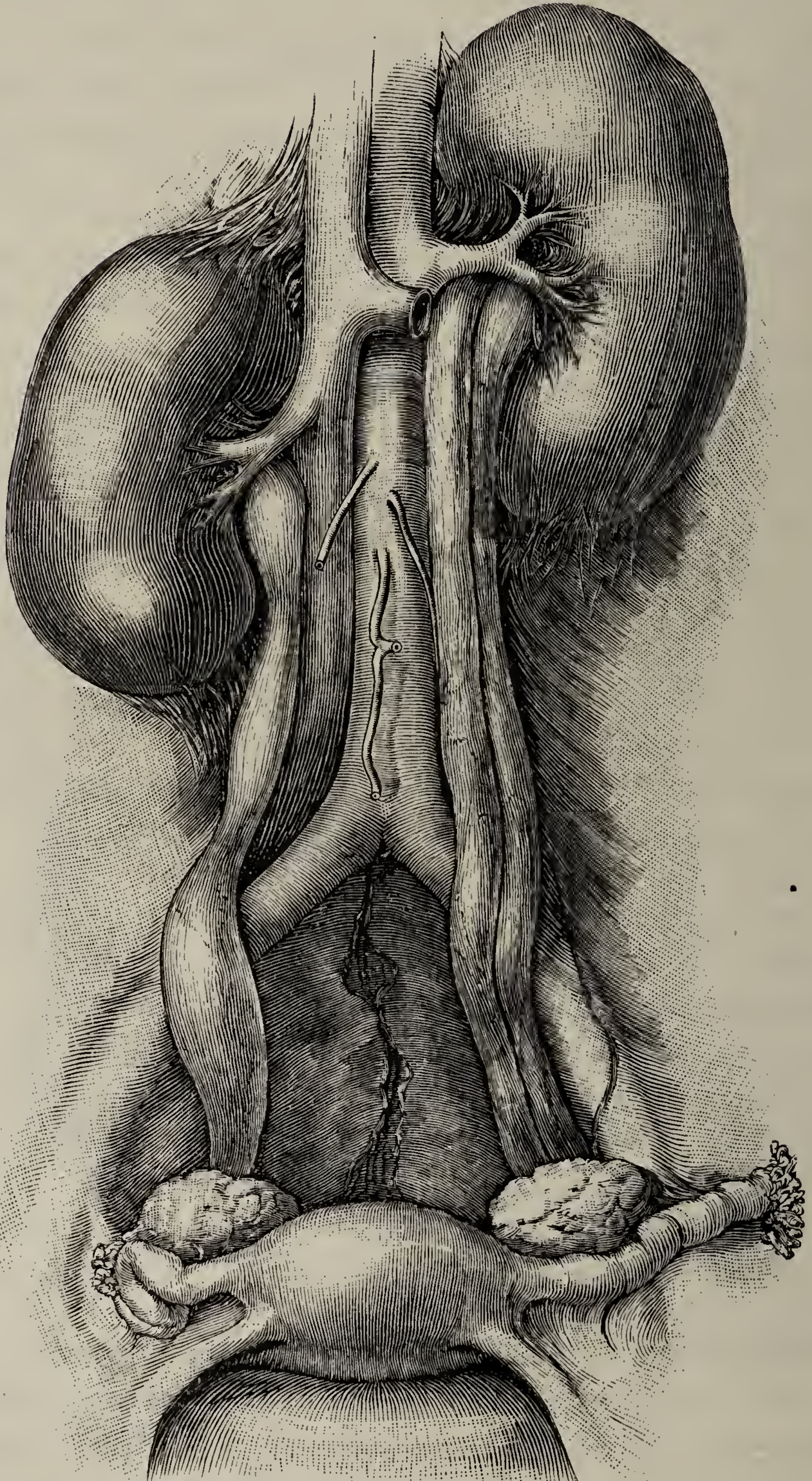

Fig. 136.—Double Ureter on the left side with Double Renal Pelvis, and abnormal position of the Right Kidney. Hydro-ureter on both sides. A complete duplication of the left ureter from the kidney to the bladder. (Otto Ramsay, *Bulletin of the Johns Hopkins Hospital*, vol. vii., No. 68-69, Nov. and Dec., 1896.)

taken, the general appearance of both kidneys was about the same, but the left was somewhat larger than the right, with its upper end 5 cm. above the upper extremity of the right kidney. The ureters were dilated, and contained clear fluid. The right ureter was about the size of the index finger; the pelvis of the corresponding kidney was dilated, the calyces being deepened, but relatively these parts were less dilated than the ureter. On the left side the ureter was double. Beginning at the hilum of the kidney by separate pelves, between which there was no communication, the two ureters ran side by side bound closely together, but entirely distinct, to the bladder, where they entered by separate orifices, 1·5 cm. apart. The dilatation of the ureters was due to malignant disease of the cervix of the uterus.

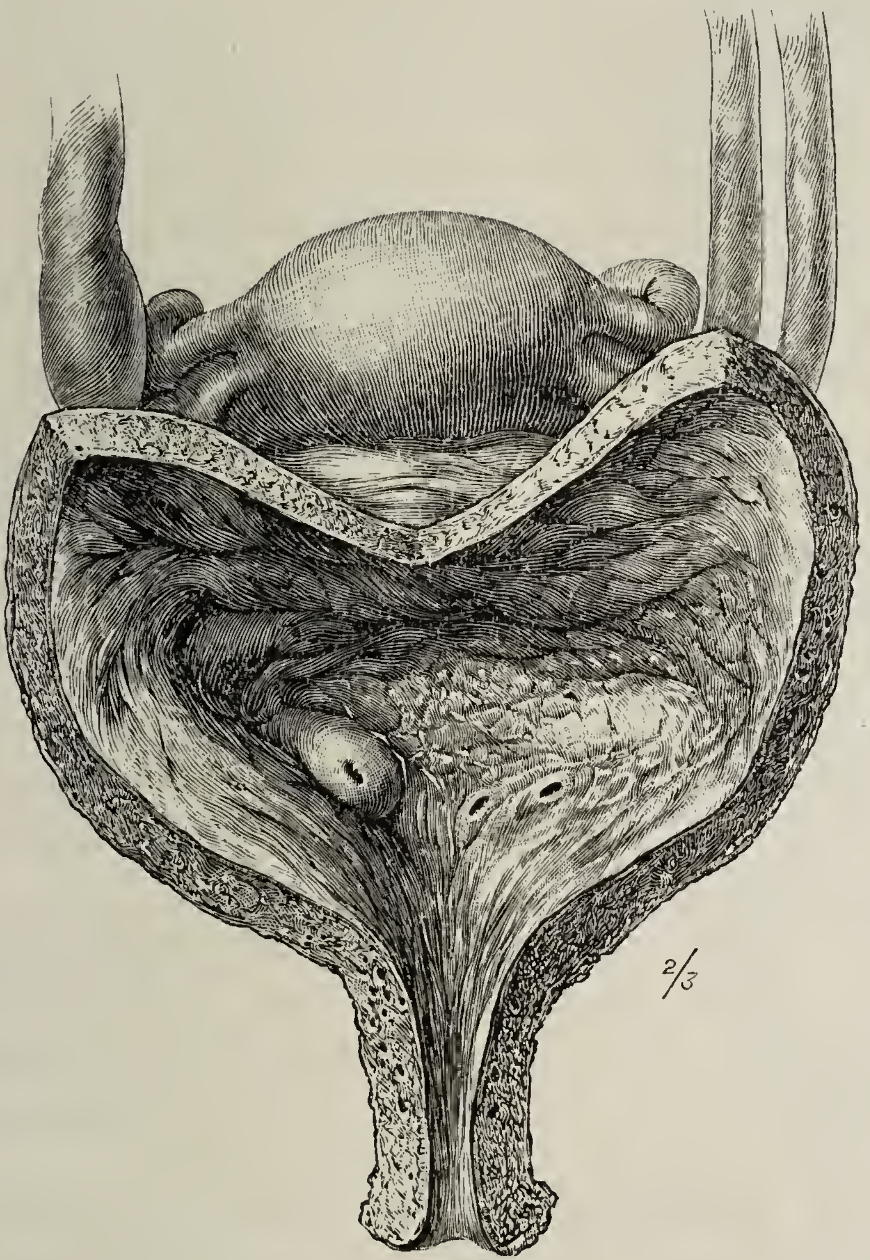

Fig. 137.—Double Ureter; Bladder laid open. Two perfect ureteral orifices on the left side. Teat-like mass on the right side with the right ureteral orifice at its summit. (Otto Ramsay, *Bulletin of the Johns Hopkins Hospital*, vol. vii., No. 68–69, Nov. and Dec., 1896.)

In a case recorded by Dr. W. Ewart each of the kidneys was furnished with two distinct pelves and ureters which ended separately in the bladder. All four ureters were pervious, a condition which would have sorely tried the skill of the ingenious inventors of instruments for catheterising and compressing the ureters for diagnostic purposes. Each kidney presented faint indications of having been double; each was larger than normal, and consisted of an upper and a lower portion which were continuous. In both kidneys the ureter of the lower portion was uniformly dilated and much ulcerated, and the corresponding portion of the gland was a sacculated cyst nearly devoid of any secreting tissue. The upper part was in an earlier stage of tubercular disease; the upper ureters were normal. The bladder and prostate were tuberculous and ulcerated. The patient was a man, aged forty-five, who died of tuberculous disease of the urinary organs and lungs.

In cases of double ureters the two ducts generally join together close to their termination or else enter the bladder side by side. Occasionally, however, one of them may deviate from the usual course, as in a case reported by Jacques,* in which there were double ureters and pelves on each side. On the left side the two ducts opened into the bladder side by side; on the right side one of the ureters was inserted in the normal position, while the other opened midway between the opening of the first and the vesical meatus.

Kidneys with double pelves and double ureters are frequently the subjects of calculi.

In some cases of this kind the double ureter is an advantage, for cases have been recorded where one ureter has been blocked by a stone while the other has been still free to transmit urine. In cases of this description that part of the kidney corresponding to the blocked ureter is generally atrophied.

Abnormal terminations of the ureter are by no means uncommon, and instead of ending in the bladder the ureter may open into some part of the urethra, the seminal passages, the vagina, or even the rectum. In the child from whom the specimen shown in Fig. 138 was taken both ureters terminated in the urethra.

These anomalies are directly dependent upon errors of development and are usually associated with other congenital deformities; indeed, the rarer varieties, such as openings into the lower part of the vagina or the rectum, are seldom found except in monsters or extremely mal-developed fœtuses.

* *Presse Medicale*, April 17th, 1897.

Among a number of cases of this description which have been collected by Secheyron there are many examples of extensive mal-development. In one the left ureter ended blindly in the bladder, while the right one had no connection at all with the bladder, but gradually becoming very narrow, finally opened by a very small aperture into the rectum; and this condition was still further complicated by the presence of kidneys of unequal size, and an imperforate anus. Other cases were associated with a double uterus or a double uterus and double vagina, and in one of the latter class the right vagina communicated with the rectum, while the left vagina received *the only ureter present.* This case is further interesting from the fact that there were two kidneys situated in the concavity of the sacrum, but the report does not state whether the single ureter communicated with both the organs or with only one.

There is a specimen in the Middlesex Hospital Museum in which both ureters are imperfectly developed and their vesical ends are impervious; they also appear not to communicate with the pelves of the kidneys. The right kidney forms a cyst the size of the fist with partial septa representing the divisions between the calyces; the left kidney presents great dilatations of the pelvis and calyces, which, however, are still bounded by a narrow border of renal tissue.

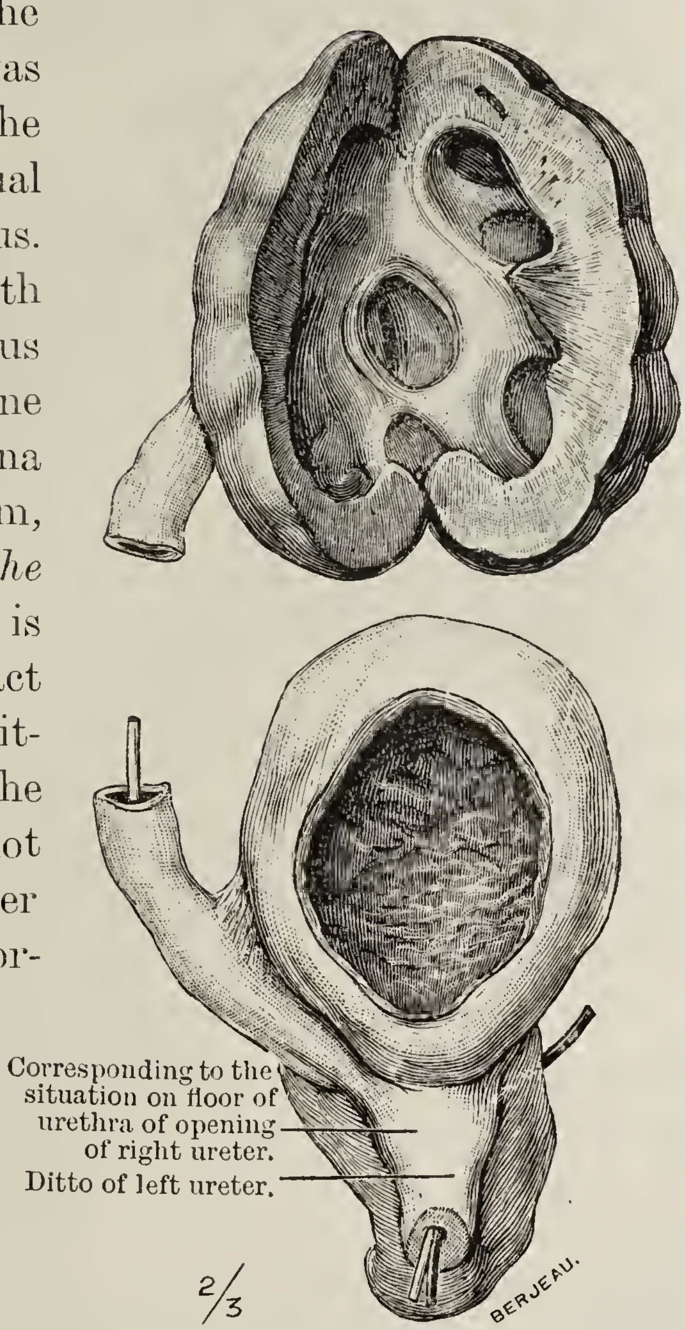
Corresponding to the situation on floor of urethra of opening of right ureter.
Ditto of left ureter.
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Fig. 138.—Kidney of a child with Hydronephrosis, Ureters terminating in Urethra. (Guy's Hospital Museum, No. 1689.)

When the ureter terminates blindly in the wall of the bladder, it may give rise to a cystic tumour projecting into the vesical cavity due to the pressure of the urine above (Figs. 137, 139, and 140); the kidneys in such cases are sometimes hydro-nephrotic and sometimes atrophied.

In order to clearly understand these abnormalities some brief reference must be made to the mode of development of the genito-urinary organs.

The canal of Wolff, from which the ureter is ultimately developed, appears quite early in the course of development.

Anteriorly this duct terminates in the mesonephros; posteriorly it opens into the ventral part of the cloaca, which is converted into the bladder and part of the urethra; and along its inner side it is connected with the Wolffian tubules which assist in the formation of the mesonephros or Wolffian body.

The ureters arise as tubular outgrowths from the lower parts of the Wolffian ducts and each terminates behind in the metanephros, which becomes the permanent kidney. After a time the ureters become separated from the Wolffian ducts and, becoming placed anteriorly to them, finally open into the bladder. Another duct —the duct of Müller—runs along the inner side of the posterior part of the Wolffian duct and also opens into the ventral part of the cloaca.

The Wolffian tubules and duct in the male develop into the seminal passages, while in the female portions of them remain as the parovarium—a rudimentary organ. In some female animals the lower part of the duct persists as the duct of Gartner, and as such may sometimes be traced in sections across the body or neck of the uterus in the human being.

The upper part of the duct of Müller becomes the Fallopian tube in the female, and the lower part unites with its fellow of the opposite side to form the uterus and the vagina. In the male it atrophies.

A glance at this process of development at once explains the abnormalities which occur at the lower end of the ureter. If, for instance, the ureter fails to become separated from the Wolffian duct, it will open into some portion of the seminal passages which are developed from the Wolffian duct.

In other cases the ureter, when separated from the Wolffian duct, does not become placed far enough forward to open into the bladder, but opens into the urethra instead; and lastly the ureter, in place of becoming attached to the ventral part of the cloaca, becomes attached to the dorsal part, which is converted into the rectum.

Prolapse of the ureter.—This condition is usually congenital, but it may also be acquired. Out of thirteen cases collected by Blumer, ten were considered to be of congenital origin, and of these five died in early childhood, death usually taking place through septic infection of the urinary tract. The extent of the prolapse varies from a small pouch to a long projection (Fig. 140), which in females sometimes appears externally through the urethra—as happened, for instance, in a case recorded by Davies-Colley of a child aged eighteen months, in which the prolapsed portion presented from the mouth of the urethra as a vascular funnel-shaped projection one inch in length and half an inch wide.

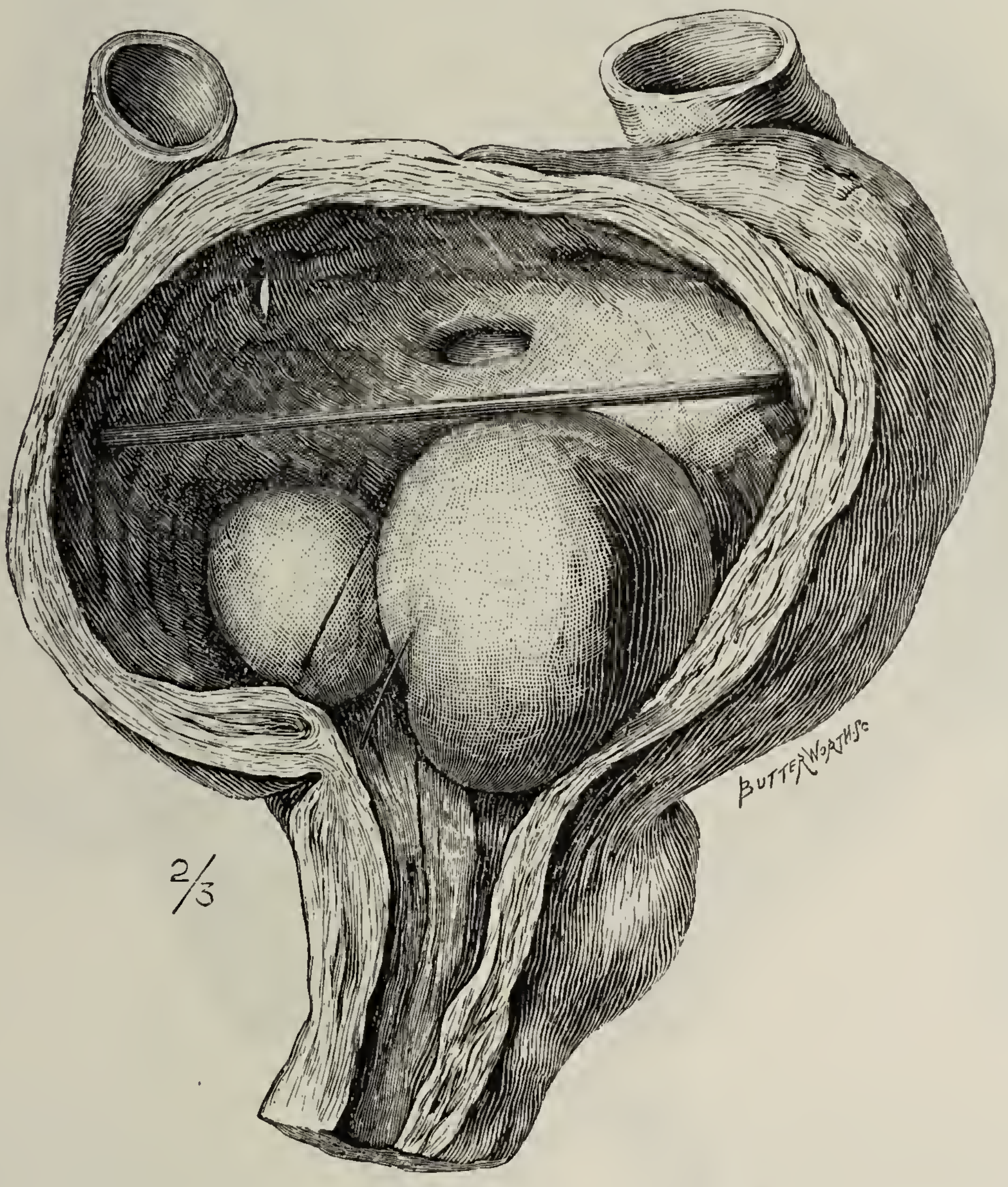

Fig. 139.—Smith's case of Prolapse of Ureters into the Bladder. The vesical ends of both ureters form pendulous pouches hanging into the cavity of the bladder. The openings of the ureters are mere pin-holes, into which bristles have been passed. (*Trans. Path. Soc. Lond*, vol. xiv., Pl. 6, 1863.)

The cause of these congenital cases has been thought to depend upon a want of support to the walls of the ureter as they enter the bladder, due either to an unusually direct opening through the bladder wall, whereby the ureter is deprived of the support which it usually obtains when it makes the passage obliquely (Boström), or to an actual deficiency in the muscular tissue of the bladder wall itself (Burckhard).

The acquired cases are usually accompanied by some stenosis of the ureteral orifices. This is well exemplified in a case recorded by Sir Thomas Smith in which the patient had all the signs of urinary obstruction in an extreme degree, the result of previous gonorrhœa. The vesical ends of both the dilated ureters were prolapsed and formed pendulous pouches, while their openings, reduced to mere pin-holes, were situated on the most prominent part of each pouch; the left pouch was the larger, and in the right one there was a stone about the size of a cob-nut. Sir Thomas has suggested that the prolapse in such a case as

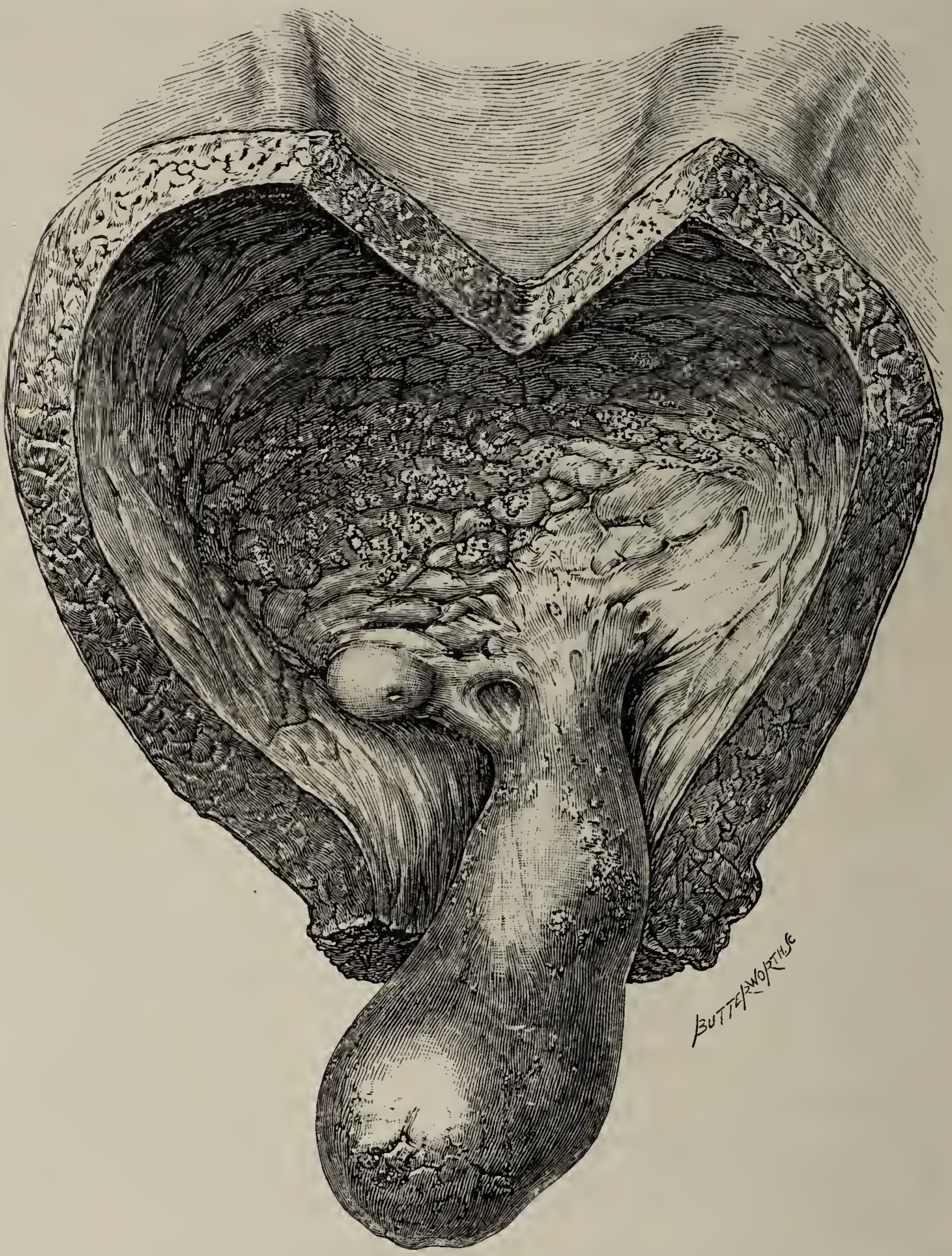

Fig. 140.—Prolapse of the Mucous Membrane of the lower end of the Ureter and of adjacent part of Bladder. ("Two Cases of Ureteral Abnormality," by George Blumer, M.D. *Bulletin of the Johns Hopkins Hospital*, No. 66-67, Sept. and Oct., 1896.)

this may be due to the disproportionate size of the tubes of the ureters and pelvis of the kidneys on the one hand and the vesical orifices of the ureters on the other. The result of this would be that when the cavities of the ureter and pelvis have reached a certain size, the urine within them will be subjected to the pressure of the abdominal muscles as are the contents of the intestines and other hollow viscera, and so during the acts of defæcation and micturition the lower parts of the ureters would be subjected to a considerable downward pressure, since their lower orifices only allow a very slow escape of the urine collected above.

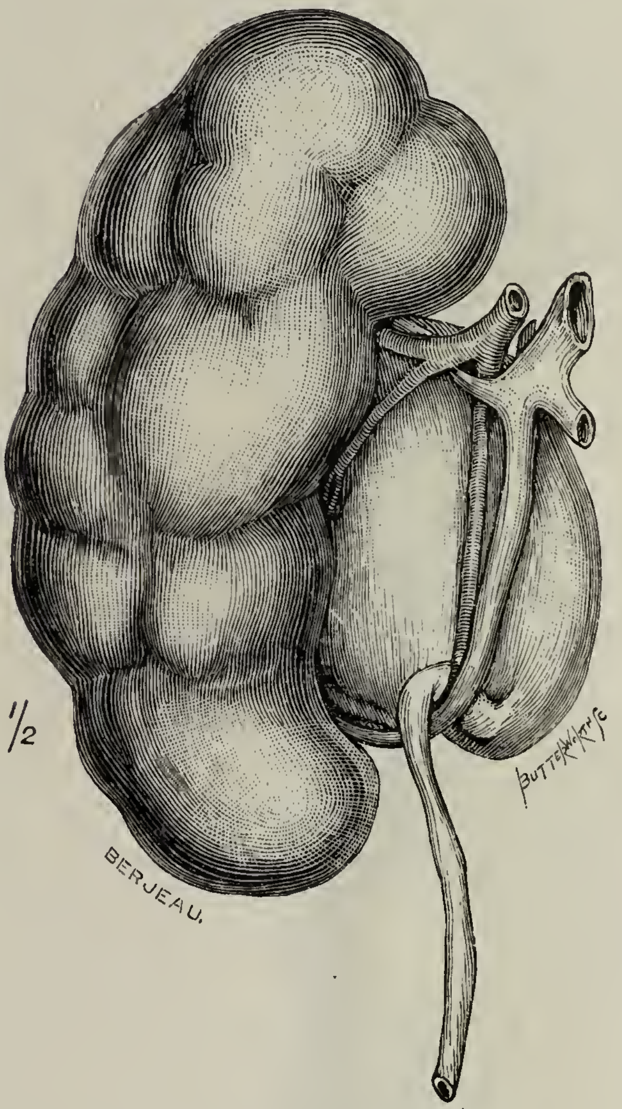

Fig. 141.—Ureter compressed by renal vessel, causing hydro-nephrosis. (Guy's Hospital Museum.)

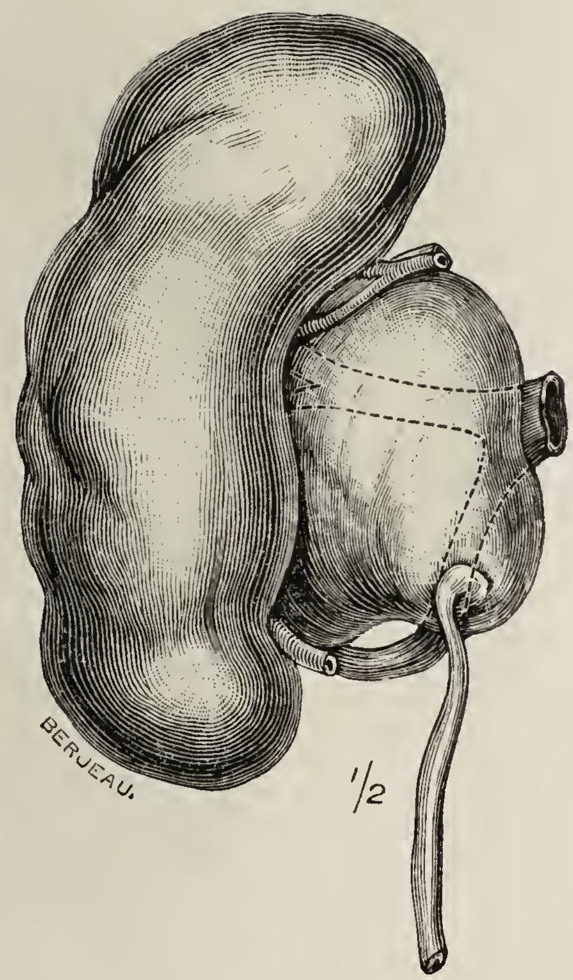

Fig. 142.—Ureter kinked over renal vessel, causing hydro-nephrosis. (Guy's Hospital Museum.)

Blumer has reported a case in which the prolapse appeared to depend upon stenosis of one ureteral orifice the result of a previous cystitis.

In a case recorded by Fletcher Beach the bladder contained a pouch opening into a dilated coiled tube which proved to be a third ureter and communicated with the right kidney by a smooth-walled cavity which was shut off from the remaining part of the renal substance. In this case the two other ureters opened naturally into the bladder just behind the pouch.

The most common symptom of the congenital cases is some difficulty in micturition, which may be accompanied by pain.

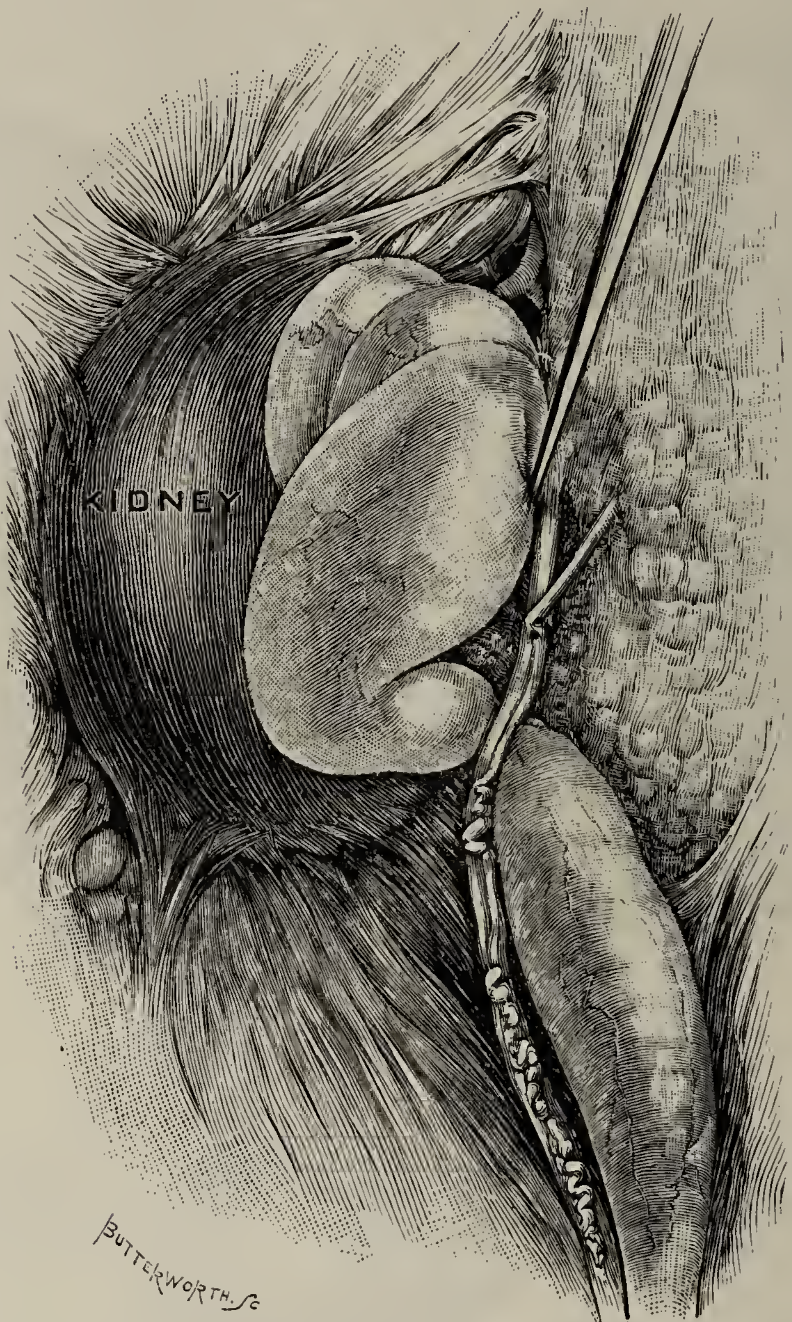

Fig. 143.—Kinking of the Right Ureter from the passage of the right ovarian vein over the dilated Ureter. Ureter compressed by uterine cancer. (*Bulletin of the Johns Hopkins Hospital*, Sept. and Oct., 1896, p. 175. Dr. Blumer's case.).

Compression of ureter by abnormal renal artery or vein. —Obstruction of the ureter is sometimes caused by the renal artery or vein, which, taking an abnormal course, winds round the ureter in such a manner as to compress it and obstruct its lumen. Israel* has met with a case of compression of the orifice of the ureter by the posterior branch of the renal artery which he remedied by operation. A condition of this kind is well illustrated by Figs. 141 and 142, which show the anterior and posterior views of a kidney in which an abnormal branch of the renal vein is passing over the ureter and constricting it.

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* *Berlin. Klin. Woch.*, Feb. 27, 1900.

Occasionally other vessels besides those arising from the kidney may constrict the ureter. Fig. 143 is an example of such a condition resulting from the passage of the right ovarian vein over a dilated ureter. The case, which is reported by Blumer,* was one of carcinoma of the uterus, which had given rise to moderate dilatation of the ureters. The right ureter was very much more dilated in the upper part of its course than in the lower, and at a distance of 5 cm. from the hilum of the kidney there was a sharp bend in the ureter, which was much constricted at this point by the passage over it of the ovarian vein, the walls of which were at this point thickened.

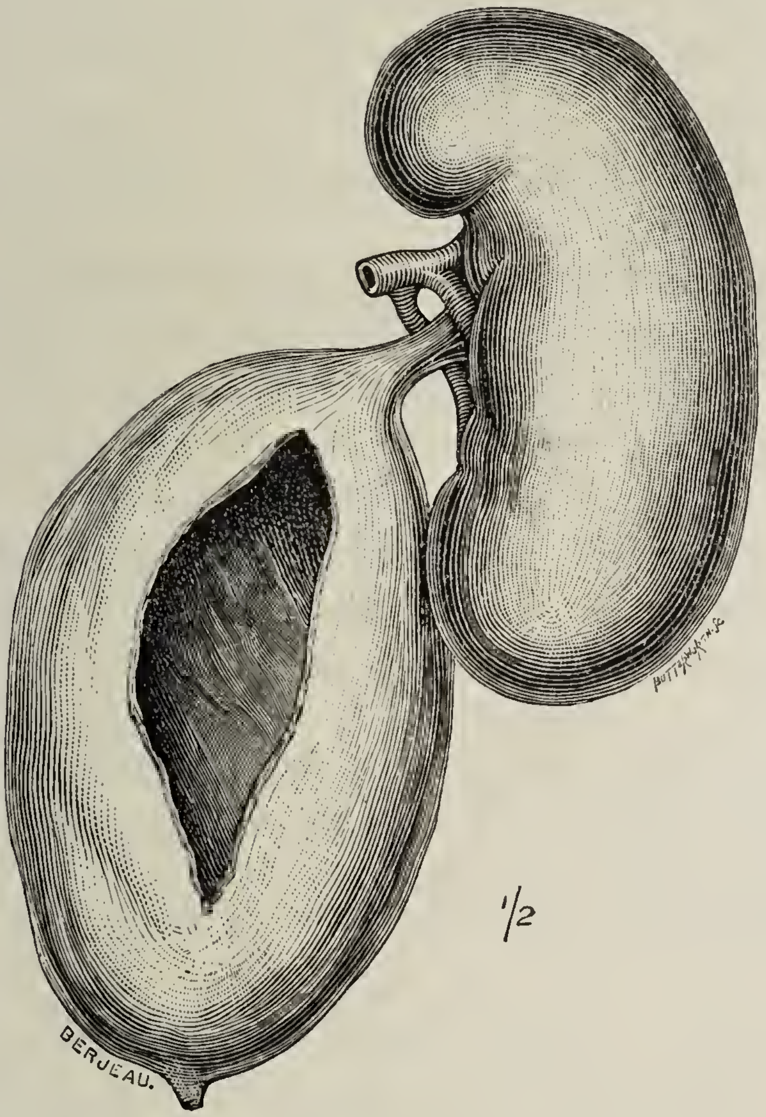

Fig. 144.—Saccular Dilatation of the Ureter just below but not involving the Renal Pelvis. (Guy's Hospital Museum, No. 1704.)

Stricture of the ureter, apparently congenital in origin, has occasionally been recorded, and is usually accompanied by hydronephrosis or atrophy of the corresponding kidney, but sometimes, the ureter immediately above the stricture dilates while the pelvis retains its normal size, as in Fig. 144.

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* *Johns Hopkins Hospital Bull.*, Sept. to Oct., 1896.

The figure on p. 441, Vol. I. is an illustration of great dilatation of the ureters in a new-born child, resulting from a congenital obstruction of the urethra caused by torsion of the penis (*see Lancet,* June 8th, 1895; also Morris, "Injuries and Diseases of Genito-Urinary Organs," pp. 162–163).

An interesting case of a somewhat similar nature has been recorded by Shattock in the *Transactions* of the Pathological Society (vol. xxxix., p. 185), in which there was an imperforate urethra in a fœtus of about the fourth month, which resulted in enormous dilatation of the bladder and ureters.

Congenital absence of the ureter is always associated with absence of the kidney.

Transposition of renal pelvis and and renal artery.—Lastly, a peculiarity of some importance was in 1866 described by Hilton Fagge,* from a dissecting-room subject. The ureter lay in front of the renal artery and vein at the hilum, not behind them. This case shows, more especially as the usual flattening of the posterior surface was also absent, that it is not possible to say with absolute certainty from the relative position of the ureter and blood-vessels, whether a kidney, after its removal from the body, is a right or a left one. Fagge had not found mention in any work on anatomy that the ureter is liable to this change of position. It must be exceedingly rare.

* *Path. Soc. Trans. Lond.*, vol. xvii., p. 171.

CHAPTER III.

PALPATION, INSPECTION, AND CATHETERISATION OF THE URETER.

For diagnostic purposes in renal and ureteral affections it is necessary to be familiar with the several ways of examining the ureter.

The circumstances under which an examination (without making an "exploratory operation") of the ureter has been recommended are the following:—

1. To ascertain the presence of and to localise a stone in the ureter. This was first suggested by Simon, then by Galland in his treatise on foreign bodies in the ureter. In a few instances rough, gritty substances have been felt during ureteral catheterisation by Desnos, Kelly, and Albarran.

2. To ascertain by palpation the condition as to thickening, induration, or tenderness of the ureter in tuberculous or other long-standing disease of the kidney.

3. To gain information from the different appearances of the two ureteral orifices (by cystoscopic examination), and by separate examination of the urine drawn off from the ureters (by catheterisation of the ureters), if either—and if only one which—kidney is diseased, when this is not evident from other symptoms. It settles the question whether a doubtfully situated urinary lesion is in the superior or inferior part of the urinary tract.

4. To ascertain the characters of the secretion of the opposite kidney by catheterising the ureter, before performing nephrectomy in certain cases.

Catheterisation of the ureter is far from being generally requisite for this purpose, because in many cases the information afforded by the course and symptoms of the disease is quite sufficient.

5. To ascertain the existence of a second kidney by inspection of the ureteral orifice and by withdrawing by means of the ureteral catheter some urine directly from the ureter. This

entirely does away with the pretext for an abdominal exploration of the opposite kidney for this purpose, at any rate in the female.

6. To ascertain the patency of the ureter in cases in which stenosis or some other form of obstruction is suspected.

7. For the treatment by dilatation of stricture of the ureter. This is not to be recommended.

8. To irrigate the ureter and pelvis of the kidney in cases of chronic suppurative ureteritis and pyelitis. This, in my opinion, is unsurgical and a mode of treatment which ought not to be adopted.

9. To facilitate the discovery of the ureter when in its normal position, or to localise it when out of position, during the progress of such operations as vaginal and abdominal hysterectomy or the removal of pelvic and abdominal tumours.

10. As a guide during the performance of the operations for uretero-vaginal fistula, and uretero-ureteral anastomosis in the lower part of the duct; and also during the early after-treatment of these operations in certain cases.

11. To break up blood-clot, or a plug of muco-pus impacted in the ureter (Morris).

A closer attention to the anatomical course and to the relations of the ureter in the different parts of its course has made palpation of the ureter an adjunct in clinical investigation; whilst the recent improvements in methods of illumination of the bladder enable the surgeon to inspect the ureteral orifices, facilitate the catheterisation of the ureters in women, and render it possible in men.

Palpation.

There are four ways of palpating the ureter—namely, the abdominal, the vaginal, the rectal, and the vesical.

(1) **Abdominal palpation.** — Under certain conditions the abdominal section of the ureter can be felt through the abdominal parietes. Provided the patient is thin and the abdominal walls are supple and easily depressed, a calculus or a thickened tender ureter can be pretty readily distinguished; but if the abdominal walls be fat or very muscular, or if the patient be highly nervous and the muscles contract and harden under the fingers, no indication of their presence is afforded by palpation. The normal ureter cannot, I think, be detected through the parietes, certainly not anywhere but at the brim of the pelvis. We cannot, I believe, under any condition of the parietes, fat or thin, mus-

cular or flabby, be sure that we feel the normal ureter by abdominal palpation; it needs the impaction of a calculus or a thickened and tender state of its walls or of its investing fibro-cellular tissue, to be able to make it out with certainty.

The course of the ureter in the abdomen is indicated on the surface of the body as shown in the annexed figure (Fig. 145). It is represented by a line drawn from the place of origin of the ureter near the kidney to the place where it crosses the brim of the bony pelvis.

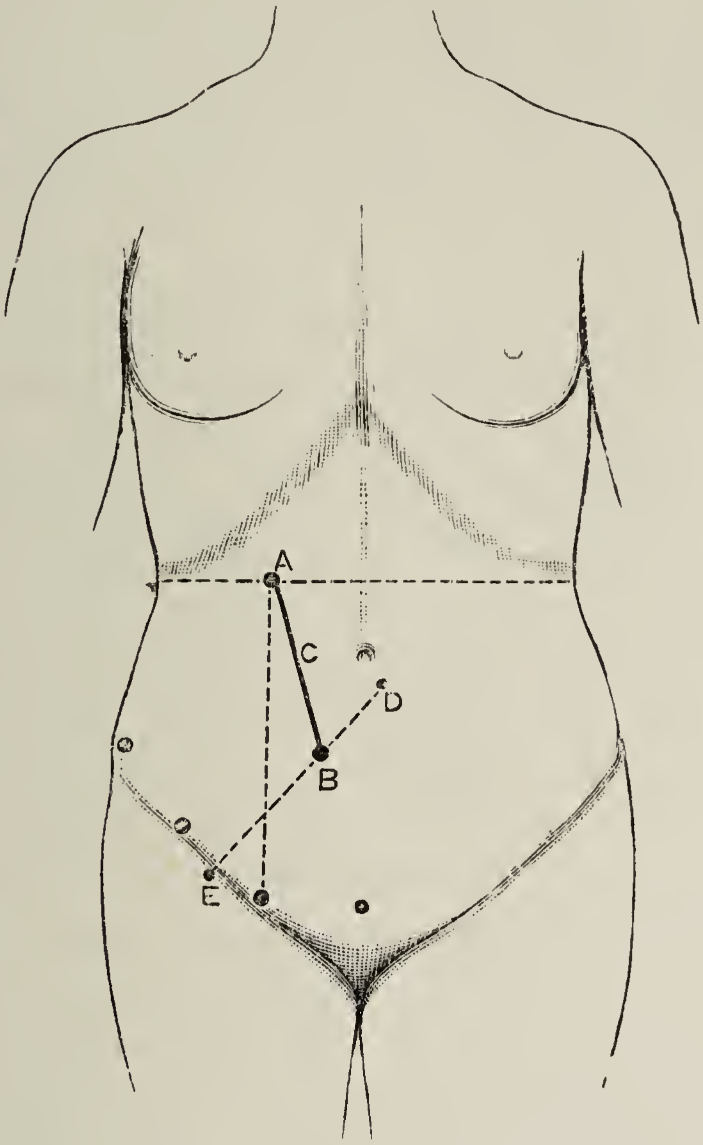

Fig. 145.—Diagram showing Surface Line of abdominal portion of Ureter.

A, Commencement of ureter; B, ureter at brim of pelvis; C, line of abdominal portion of ureter; D, point of termination of abdominal aorta from which a line is drawn to the point E, midway between symphysis pubis and iliac spine, in order to find B. Horizontal dotted line shows level of last ribs. The vertical dotted line shows how to find A.

The upper point, indicating the upper isthmus of the ureter, is at the intersection of a transverse line between the tips of the twelfth rib with a vertical line drawn upwards from the junction of the inner and middle thirds of Poupart's ligament. The lower isthmus (a varying point, indicating the crossing of the ureter over the iliac artery) is here shown corresponding to the junction of the upper and middle thirds of the line of the common and external iliac arteries, viz. from half an inch below and to the left of the umbilicus to midway between the anterior superior spine of the ilium and the symphysis pubis.

A line drawn between these points fairly represents the line of the ureter in the abdomen (Fig. 145). It is in this line that we must feel for the ureter, and it is at the lowest part of this line that we are most likely to detect it: it is here that we compress it against the brim of the bony pelvis; it cannot be compressed against the yielding psoas muscle on which it is lying higher up.

The patient during the examination must be lying on the back with the knees slightly drawn up, and the surgeon should gradually and gently depress the abdominal walls with his fingers and draw or roll them over the tissues from within outwards.

(2) **Vaginal palpation.**—The terminal $2\frac{1}{2}$ inches to $2\frac{5}{6}$ inches of the ureter is readily palpated in the female through the anterior and lateral fornices of the vagina. Here again, however, much depends on the degree of thickness and tenderness of the mucous membrane and sub-mucous tissue, and on the condition (normal or abnormal) of the ureter and its peri-ureteral cellular tissue. From the descriptions sometimes given in the books and papers of certain gynæcologists, it would seem that it is only necessary to introduce the index finger into the vagina, and pass it over the surface of the anterior and lateral fornix to feel the ureter in every case with the greatest ease; but this is not so, and the practitioner need not feel humiliated at what he may otherwise suppose is his lack of tactile sense, if he does not succeed in feeling this flat or tape-like body. It is undeniably very difficult to distinguish the *normal* ureter by palpation.

Unless it contains a foreign body, or its lower extremity is strictured, or it is hypertrophied by the constant action of its muscular coat owing to irritation in the kidney or in its own mucous membrane, or it is thickened and indurated by simple infective or tuberculous ureteritis or peri-ureteritis, the ureter sometimes cannot be made out by vaginal palpation. I constantly make a vaginal examination for the ureter, and I have frequently been unable to feel it at all; on the other hand, I have repeatedly felt it very distinctly—sometimes as a freely movable thickened cord rolling under the finger; sometimes as a slightly movable, or nearly fixed cord, hard and like a length of flexible catheter; at other times as an irregular and indurated fusiform lump, very sensitive, very tender, even acutely painful on pressure.

Under such circumstances it affords useful clinical information and in some cases I have found it a sufficient guide in determining which kidney is the seat of the disease.

It is of importance that students and practitioners should have correct ideas on the subject of ureteral palpation, whether by the vagina, rectum, or abdomen, and that they should not be led to suppose that, like the normal vas deferens after it has emerged from the inguinal canal, the normal ureter has only to be felt for to be recognised.

It is stated that during pregnancy the ureter can be felt over an extent of four inches (10 cm.), and is the more readily made out because the head of the fœtus forms a *point d'appui* against which it can be palpated. But here again I would warn the practitioner against expecting too much. My practice, it is true, does not require me to be very frequently making vaginal examinations on pregnant women, but my experience in this direction is sufficient to convince me that the result of such an examination in search of the normal ureters is often doubtful when it is not actually negative.

The part of the ureter which is capable of being felt through the vaginal wall (this is easily determined on the dead body by injecting the ureter from the kidney) is about three inches or a little less, or, roughly speaking, about a quarter of the whole length of the duct. It is that part which extends from the vesical orifice of the ureter backwards, outwards, and upwards to the base of the broad ligament and towards the wall of the true pelvis.

It is in the superior third of the anterior and lateral wall of the vagina that the examination must be made; and it is at the part between the level of the internal orifice of the urethra and the anterior *cul-de-sac*, where the tissues are very lax, that the ureter will be most readily felt.

The examination should be made very gently, and the finger should be passed comparatively lightly over, not pressed firmly against, the vaginal surface. The ureter courses about mid-way between the cervix uteri and the wall of the pelvis, and by hard pressure the ureter is displaced before the finger in a direction towards the pelvic wall.

The right ureter should be palpated with the pulp of the right index finger, and the left ureter by that of the left index finger. The left ureter is not nearly so easily made out by the right index finger, as the right hand has to be over-pronated or over-supinated and turned upwards for the purpose. Probably this is a reason why the right ureter has been so much oftener felt than the left.

Sänger cautioned against mistaking the uterine artery and the muscular fibres of the levator ani or obturator internus for the ureter, but, though anatomical neighbours, they ought not to be causes of practical error. It is much more important to bear in mind that a band of thickened peri-vaginal or peri-uterine cellular tissue may be present and be possibly mistaken for a thickened ureter. This confusion is more likely to happen if one hand is depressing the hypogastrium at the same time that the finger of the other hand in the vagina is pressing the vaginal vault upwards and backwards.

When by bimanual examination the ovary is felt in its normal position, the ureter should be felt for by directing the index finger below and slightly behind the ovary. If the hand which is depressing the abdominal parietes is now gradually relaxed, the cord or band, if it be the ureter, will still be felt; whereas if it be the Fallopian tube, or a thickening in the broad ligament, it will recede with the relaxation of the pressure on the abdominal wall and cease to be in contact with the forefinger in the vagina.

(3) **Rectal palpation.**—The lower extremity of the ureter when occupied by a foreign body, or in a state of disease, can be felt through the rectum of the male but less readily than through the vagina in the female. A calculus impacted in the lower end of the ureter has been felt and removed through the rectum.

It is through the antero-lateral wall of the bowel and a little higher than the level of the base of the vesicula seminalis that we feel for the ureter. The pulp of the finger should be directed towards the back of the bladder and pushed far up beyond the upper edge of the prostate; afterwards the finger pulp should be turned towards the lateral wall of the pelvis, and whilst still pushed as far as possible, it should traverse the wall of the rectum forwards and backwards. The examination is difficult, and, if the prostate is much enlarged the detection of the ureter is impossible. The normal ureter is not likely to be distinguished, even with a thin perineum and a normal prostate.

(4) **Vesical palpation.**—By digital examination through the dilated urethra of the female much can be learnt of the condition of the ureteral orifice, whether it is dilated, swollen, œdematous, prolapsed, or occupied by an impacted calculus.

I have been guided as to which kidney to operate upon in a case of tuberculous renal disease in a young woman in whom most of the symptoms pointed to the bladder and not to the kidney, by finding the left ureter patulous, œdematous, and somewhat prolapsed into the vesical cavity. This decided me to remove the left kidney, which was found at the operation to be extensively diseased.

Other instances of the advantages of vesical palpation are furnished by cases of calculus impacted near the vesical orifice of the ureter (*see* chapter on Calculus in the Ureter, p. 446).

INSPECTION.

Inspection of the ureter without an exploratory, *i.e.* a cutting, operation is necessarily limited to an examination of the vesical orifice. This can be made in two ways: (1) by means of light thrown into the bladder along a tube (an endoscope) passed through the urethra; (2) by the cystoscope, which carries an electric light at its vesical extremity.

Inspection of the ureteral orifice within the bladder can give us information (*a*) as to the state of the orifice, whether normal, absent, strictured, dilated, œdematous, prolapsed, ulcerated, or surrounded with growth of a villous character, or otherwise; (*b*) as to the manner in which the urine enters the bladder from the ureter, whether normally coming as a little jet every twenty or thirty seconds, or coming more slowly or more frequently, or perhaps dribbling away: in ureteral fistula information will be afforded as to the side involved if urine can be seen flowing from one orifice and not from the other; (*c*) as to whether the urine is clear and limpid as normal, or tinged more or less with blood or pus.

Bozzini, in 1805, was the inventor of this mode of examination, but no particular attention was given to his method; and though Segalas, in 1826, and Desormeaux, in 1856, have the credit of making attempts to revive interest in this mode of investigation, it was not until the introduction of recent improvements in electrical illumination that any serious efforts were made by surgeons to gain information by means of direct inspection of the bladder and ureteral orifices.

Inspection by the aid of external light, *i.e.* by the endoscope.—It is to Grünfeld (1881) that we owe the chief progress in this procedure.

Desormeaux's endoscope consisted of a tube and the source of illumination, in one apparatus.

Grünfeld separated the illuminating power from the tube. The light is reflected by the ordinary laryngoscopic frontal mirror from a gas jet or electric lamp held opposite to the examiner; or from a lamp fixed at the centre of a large concave frontal mirror which is adjusted to the head of the observer by a frontal band and pierced by two holes opposite the eyes (the photophore of Clar). The light is directed along a tube from 15 or 16 cm. long for the male, from 10 cm. upwards for the female, and corresponding in diameter to Nos. 22–26 French gauge, called the endoscopic tube, which is introduced through the urethra into the bladder.

Or, following Stein, the light may be sent directly along the endoscopic tube to the bladder from an electric lamp fixed above and between the eyes of the observer by means of a strap and buckle round the head.

The endoscopic tubes may be either open at their ends or closed by a piece of glass.

The method of using the endoscopic tube and light is very simple, and is as follows:—

The bladder is washed out. The patient is in the lithotomy position with the buttocks raised high, or she is in the knee-chest position. The tube, well anointed with boroglyceride, is introduced into the bladder, and the light is directed through the tube. It is only in women that this method of examination is practically useful.

Grünfeld advises deflecting the tube on one side so that its wider external orifice makes an angle of about 30° to 35° with the axis of the urethra in order to bring the opposite ureteral orifice into view, and at the same time, if the patient is on her back, raising it a little towards the symphysis pubis.

In this direction the tube is pressed inwards till its extremity is from 2½ to 3 cm. within the urethral opening of the bladder.

The orifice of the ureter will then appear as a small slit, a small linear depression, or a slight dimple; or it may be as a little rounded elevation which becomes more pronounced and on which the orifice is seen when urine escapes from the ureter.

Inspection by the aid of internal light, or, in other words, by the cystoscope.—With the cystoscopes of Nitze, Leiter, Casper, or Albarran the greater part of the bladder can be inspected either in the male or female; all parts, in fact, except a small area of the posterior wall of the region in the immediate neighbourhood of the neck of the bladder, *i.e.* immediately behind the urethral opening. Nitze, to overcome this, constructed a second (No. 2) and a third (No. 3) cystoscope, in which the window and prism are placed at *the anterior surface of the beak,* and *at the summit of the angle formed by the beak and body of the instrument,* instead of in the angle formed by the beak.

In using the cystoscope the patient is on his back with the thighs well bent up; the bladder is washed out with antiseptic fluid, and five to six ounces of boracic solution are injected and left in the cavity. Then the cystoscope is introduced like a catheter, and if it be one with the prism at the summit of the angle formed by the beak and the straight shaft of the instrument, the beak must be directed upwards when within the bladder. After giving it a little lateral inclination, and moving the instrument slightly backwards and forwards, the orifices of first one and then the other ureter can be brought into the field of vision.

CATHETERISATION OF THE URETER.

Methods for differentiating the urine of the two kidneys, and for ascertaining the presence of both kidneys by observing the flow of urine from each ureter, have been very varied and numerous. With the introduction of renal surgery they became a subject of increased importance, especially in reference to certain cases in which nephrectomy was contemplated. I say in "certain cases" because in the great majority the clinical and physical conditions and the history of the case give us sufficient information of the fact as to whether or not a second kidney exists, and what is its capacity for secreting.

In the history of this very modern method of investigation it is right to recall the fact that Dr. A. Tuchmann, of the German Hospital in London, as far back as 1874 had the idea of collecting the urine from one ureter whilst obstructing the other by means of intra-vesical pressure, and for this purpose invented an instrument, which he called "ureter forceps."

The description and the figure illustrating his method were given to me sixteen years ago by Dr. Tuchmann for my first work on "Surgical Diseases of the Kidney," and to this work I must refer the reader who may wish for particulars about it.

The figure shows the beak and blades of the forceps *in situ* within the bladder. The instrument is like a lithotrite in form, but more slender; its branches are made to approach each other not by the force of a screw, but by a slight spring; it has large holes to allow the urine to flow out from the bladder.

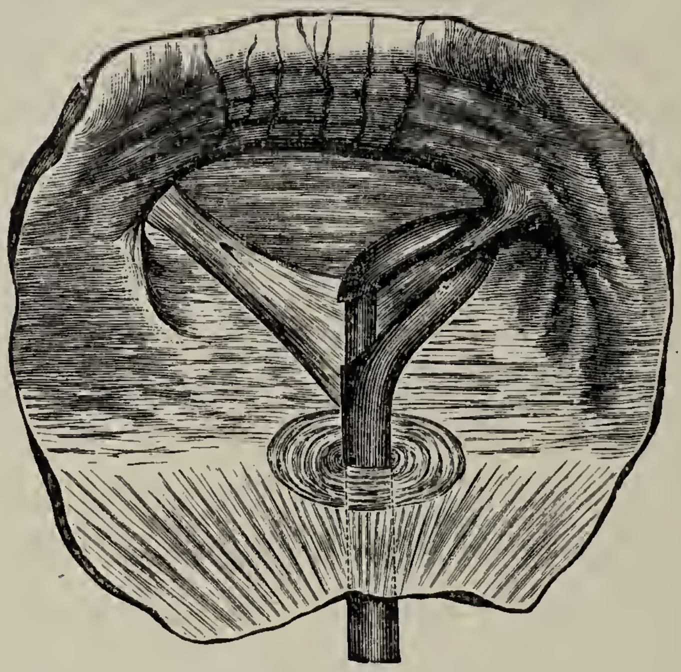

Fig. 146.—Dr. Tuchmann's Ureter Forceps applied to the Orifice of one Ureter.

The instrument is intended, when introduced into the empty bladder, to close during a certain time the valve of the ureter of the one kidney, and to collect the urine which, during this time, comes down from the other kidney.

Various other methods for accomplishing the object Dr. Tuchmann had in view—namely, the separate examination of the urine passed from each kidney—were suggested in quick succession (*see* "Surgical Diseases of the Kidney," by the present author, 1885).

Hegar and Sänger proposed the application of a temporary ligature to the ureter. It was suggested to expose, and apply a temporary ligature to the ureter through an incision such as was employed for tying the common iliac artery. Hegar applied the temporary ligature through the vagina. His suggestion was revived by Warkalla,* who proposes to pass the ligature under the ureter from the vagina, the patient being in the knee-chest position; but, instead of tying it, to exercise sufficient traction on it to occlude the canal of the ureter. He succeeded ten times out of thirteen in his trials on the cadaver. The operation, Warkalla thinks, is without danger. It is however uncertain, and is attended with the risk of passing the needle carrying the ligature through instead of beneath the ureter.

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* *Arch. f. Gyn.*, 1886, Bd. xxix., Heft ii., p. 289.

But all methods were destined to yield to the greater simplicity and precision of catheterisation of the ureters. In 1875, only a year after Tuchmann made his method known, Simon first tried to catheterise the ureters by digital guidance from within the bladder, after anæsthetising the patient and dilating the urethra.

In 1881 Grünfeld published his attempt to utilise his vesical endoscope with reflected light to accomplish the same end. In 1883 Newman of Glasgow* devised an electric lamp which he introduced into the bladder so as to illuminate the orifices of the ureters. Into each ureter he inserted a catheter, and thus collected the urine from each kidney separately.

The instruments required for this proceeding, besides the electric lamp, were two gum-elastic catheters and a speculum; all of which occupied the urethra at the same moment. The bladder was previously washed out with a warm solution of boracic acid, and distended with eight ounces of the boracic solution. It is needless to say that this method is inapplicable in the male.

In 1880 Pawlik described a plan, based on anatomical landmarks of the bladder and vagina, for catheterising the ureters directly without the necessity of chloroform and urethral dilatation. Simon's and Pawlik's procedures are practised without illumination, and Grünfeld's with reflected light. The method of Pawlik, which is very difficult, and the less difficult methods of Simon and Grünfeld, are only applicable to women.

In the male it is technically impossible to introduce large straight tubes through the urethra and to balloon the bladder, and therefore Grünfeld's and Kelly's methods (ureteral catheterisation with the endoscope and external light), and, of course, Simon's, Newman's, and Pawlik's methods are out of the question; but in women all three methods above mentioned have their advantages, and will be briefly described here.

The procedure of Simon.—The woman is anæsthetised, the urethra dilated with one of the several forms of female urethra dilators, a procedure which ought to be done gently and regularly, but not too slowly. The index finger is then introduced through the dilated urethra, and the inter-ureteral fold and the ureteral orifice at its extremity felt for. The tip of the finger is held close to the ureteral orifice, and the catheter is conducted along the finger as a guide, and made to enter the orifice of the ureter after a little manœuvring. As soon as the catheter enters the ureter it should pass onwards in the normal direction of the duct without resistance.

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* *Glasgow Med. Journ.*, Aug., 1883.

The procedure of Pawlik.—Pawlik places his patient in the genu-pectoral position, but his method can be equally well practised in the dorso-sacral, provided the head is very low and the buttocks well raised so that the viscera fall towards the diaphragm. The posterior wall of the vagina is drawn open by a large speculum, and the anterior wall thus put upon the stretch. There are then seen upon the anterior vaginal wall slight prominences of the mucous membrane, which correspond to the boundaries of the vesical trigone, which serve as a guide, and which map out a space which has been since named the vaginal trigone of Pawlik. The bladder is filled with 200 cubic cm. of aseptic fluid. Having made out with the eye and by touch the triangle of Pawlik, the surgeon passes the ureteral catheter by the urethra, and then pressing gently with the catheter upon the posterior wall of the bladder directs it along the lateral boundary of this triangle (which corresponds with the lateral boundary of the vesical trigone) to the angle which it makes with the base of the triangle. It is here that the catheter ought to enter the orifice of the ureter. With the catheter as it passes backwards and outwards the surgeon ought to be able to detect the inter-ureteral ridge, and this indicates the posterior limit, beyond which he ought not to pass before entering the ureteral orifice.

Arrived at the posterior lateral angle of the trigone, the catheter ought to be played gently backwards and forwards, rotated, elevated, and depressed, until it meets with no resistance in front of it; then it will have entered the duct, when the lateral movements will be resisted, but it can be passed forwards without resistance, and urine soon flows from the catheter in little jets.

By pushing it gently, and at the same time lowering the handle, the catheter will travel onwards to the brim of the bony pelvis; there a slight check is met with, but if the cellular tissue surrounding the ureter is normal, so as to allow of the duct being drawn away from the pelvic wall whilst it is more or less straightened out by the catheter, the catheter can be made to enter the renal pelvis.

Pawlik uses a metal instrument 25 cm. long, terminated by a bulbous tip. The beak is 1½ mm. in diameter; the eye of the catheter is very elongated with rounded edges, and is situated at the base of the beak. The shaft is slightly conical, and the beak forms with it a slight bend, and here is situated the eye. At a centimetre and a half from the outer extremity there is a handle with an index corresponding to the curve of the instrument, and a stylet can be passed along the canal of the instrument so as to close the catheter.

Pawlik* has more recently described a method of electric illumination of the bladder in a state of atmospheric distension, by introducing a little electric light through a large open speculum after dilating the urethra under anæsthesia.

Catheterisation by the aid of the endoscope and external light.—The first surgeon who practised endoscopic catheterism of the ureters was Grünfeld. As we have seen, the previous efforts had been by touch with the finger inside the bladder (Simon's) or by the anatomical landmarks on the front wall of the vagina (Pawlik). The vesical endoscope of Grünfeld consists of a simple metal tube blackened on the inside, closed by a glass plate at its vesical extremity, and wide and funnel-shaped at the other extremity.

The tube is introduced *per urethram,* and is pushed across the base of the bladder towards the orifice of the ureter.

From a frontal mirror furnished with a small electric lamp light is transmitted along this tube, and thereby a small surface of the bladder including the opening of the ureter is brought clearly into view, and the ureter can be catheterised under the eye of the operator.

The catheter is passed into the bladder parallel with and along the side of the tube diagonally opposite to the ureteral orifice it has to enter. Thus the catheter should be inserted into the bladder on the left side of the tube when the right ureter is to be sounded, and *vice versâ*. The tube is directed towards the orifice of the ureter by deflecting it, so that it makes an angle of from 30° to 35° with the median line—to the right for the left ureter, and to the left for the right ureter; at the same time the handle should be raised somewhat towards the pubis. Grünfeld devised a special sound or catheter, the distal end of which could be bent to a right angle and again straightened whilst retained within the bladder.

H. A. Kelly, in 1893 and 1894, published accounts of his method as applied to the female.

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* *Central. f. Gyn.*, May 5th, 1894.

It consists in (1) an atmospheric dilatation of the bladder induced by posture; (2) the introduction of a simple straight speculum, as a rule of small size and without fenestra; (3) the examination of the bladder and ureteral orifice by means of a reflected light or an electric head lamp.

The patient having had her bowels well opened, her bladder emptied naturally, and being preferably in a state of fasting, is placed either in the elevated (that is with the buttocks raised) dorsal, or in the knee-breast position. The dorsal position is the most convenient and least tiring to the patient, but is only serviceable in thin patients, and the atmospheric expansion of the bladder is not good in this position. For a fat woman the knee-breast position is requisite, as her bladder will not distend in the elevated dorsal posture.

A conical urethra dilator is first introduced, and afterwards a speculum, which is a simple metal cylinder 3⅕ inches long, and of equal diameter throughout, with a funnel-shaped expansion at the outer end; the diameter varies in different tubes. A tube of a size suitable to the dilatability of the urethra is selected, and as soon as the speculum is introduced air rushes into and distends the bladder. The light is now transmitted along the tube, and the inspection of the bladder and of the ureteral orifice is commenced.

The ureteral catheter or sound is passed through the tube, and, guided by the right hand and under direct ocular observation, into the ureter. If a flexible catheter is used it should be introduced into the ureteral orifice upon a stylet; but once in the canal the stylet should be withdrawn, and then the catheter may be passed onwards as far as the renal pelvis if required. Metal catheters and sounds are used if the introduction concerns only the lower end of the ureter.

Dr. Shoemaker* has invented a suction apparatus attached to the ureter catheter for removing urine from the endoscopic tube and keeping the bladder dry during catheterisation.

CATHETERISATION IN THE MALE.

Catheterisation with cystoscope and internal illumination.—All the above procedures are limited in their application to the female. In 1889 Brenner practised catheterisation of the ureters by making an important modification of Leiter's cystoscope.

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* *Annals of Surgery,* No. 22, 1895.

He affixed to the tube of the cystoscope a fine canal which opens exactly below the objective, and in which glides a fine sound or catheter, the beak of which is in the field of vision; and thus in the hands of Brown of Baltimore, of Zuckerkandl, and others catheterisation of the male ureters was rendered possible. Poirier* has published the results of his successful employment of Brenner's apparatus.

In Brenner's instrument the intra-vesical outlet of the ureteral catheter is on the convexity of the cystoscope, a principle which is now pretty generally condemned for catheterising the ureter in either sex.

About the same time Nitze † and Casper also made a great improvement in their cystoscopes by adapting them for the purpose of catheterising the ureters of the male. In Nitze's and Casper's cystoscopes the intra-vesical outlet of the ureteral catheter is on the concavity of the instrument.

This method is as applicable in the female as in the male; but with the previously described methods available, the surgeon did not need these very ingenious and complex instruments for examination of the female; though they were requisite for catheterisation of the male ureters. Some experts with the cystoscope however prefer this instrument to the endoscope, even for women.

Tuffier considers each method has its advantage and disadvantage, that one completes the other, and that it is well to employ each in turn. Speaking of cystoscopy generally, not specially in reference to catheterisation of the ureters, he expresses the opinion that the cystoscope is the method of choice.

Albarran says the method of choice is the ureter cystoscope —not the tubes and atmospheric distension of the bladder with external light after the manner of Kelly.

W. Meyer ‡ says: "Whether in the female one should make use of a cystoscope constructed on Nitze's plan or of Kelly's instrument is really a matter of taste. The manipulation with the ureter cystoscope (Nitze's or Casper's) is a very gentle one; it is also very comfortable for the patient. She rests on her back in the position used by us for bimanual vagino-abdominal palpation." In the male we have no choice; by Kelly's method, catheterisation of the ureters is in man a technical impossibility. Speaking of Nitze's and Casper's latest instruments, Meyer says both are useful and need no special improvements.

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* *Compte Rendu de l'Acad. de Méd.*, Paris, Sept. 2nd, 1889.

† Nitze, *Annales des Maladies Génito-urinaires*, Dec., 1891.

‡ W. Meyer, *Medical Review* (New York), May 1, 1897.

Albarran thinks the instruments of Nitze and Casper are difficult to handle, and states that they have scarcely been employed except by their originators. In 1897 he (Albarran) constructed a cystoscope of his own pattern, which he says is easy to handle in the male as well as in the female, and has been used by a great number of surgeons and students at the Necker Hospital. He adds that Nitze has since adopted for his own cystoscope the principal features of Albarran's.

Albarran claims for his own design that the field of vision is very wide and permits of finding the ureters as easily as with the best simple cystoscope; and that it serves at will for a simple cystoscope, for a cystoscope and irrigator, and for a ureteral cystoscope for the purpose of catheterising the ureters. It is composed of optic, ureteral, and irrigating portions, which are shown in the accompanying figures (Figs. 147 to 150).

Dr. M. L. Harris of Chicago* has devised an instrument called the "urine segregator," whereby the urines from the right and left ureters can be drawn off at the same time as they are voided by their respective ureters into the bladder. This is done by pressing the wall of the bladder (exactly in the median line) by means of a lever introduced into the vagina of the female and the rectum of the male, within the fork of the connecting piece of a double catheter introduced into the bladder.

Dr. Tilden Brown of New York † has modified Brenner's cystoscope by making a double- instead of a single-barrelled catheter attachment, with the object of catheterising both ureters approximately at the same time in favourable cases; and for relieving an irritable bladder by drawing off the urine collected in it during the time the ureteral catheter is in one ureter making its slow collection therefrom.

THE TECHNIQUE OF CATHETERISING THE URETERS BY THE AID OF THE URETERAL CYSTOSCOPE.

Before catheterisation is commenced in the male it has been recommended that plenty of fluid should be taken, so that urine may be obtained from each ureter within a short time. In women this is not necessary, because a catheter *en demeure* can be left in each ureter for an indefinite time.

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* Chicago Medical Society, Jan. 12, 1898; *Journ. Amer. Med. Assoc.*, Jan. 29, 1898.

† *Annals of Surgery*, Dec., 1899.

The cystoscope, catheters, sounds, etc., having been sterilised, and the urethral orifice, and if a female the vulva, having been well washed with an antiseptic solution, the bladder should be irrigated with boracic solution, or with a feeble solution of carbolic acid or some other antiseptic. If the urethra and bladder

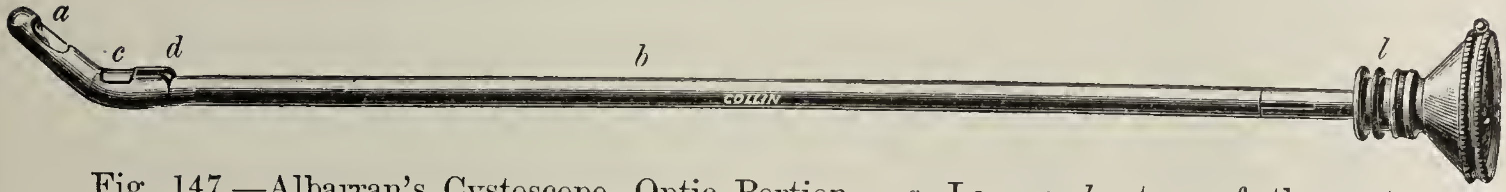

Fig. 147.—Albarran's Cystoscope, Optic Portion. *a*, Lamp; *b*, stem of the cystoscope enlarged at its lower end so as to receive the prism *c*, and presenting above the prism an opening *d*. A ring in contact with the electric conductors, and which permits of the cystoscope being turned without breaking the current, is placed at *l*.

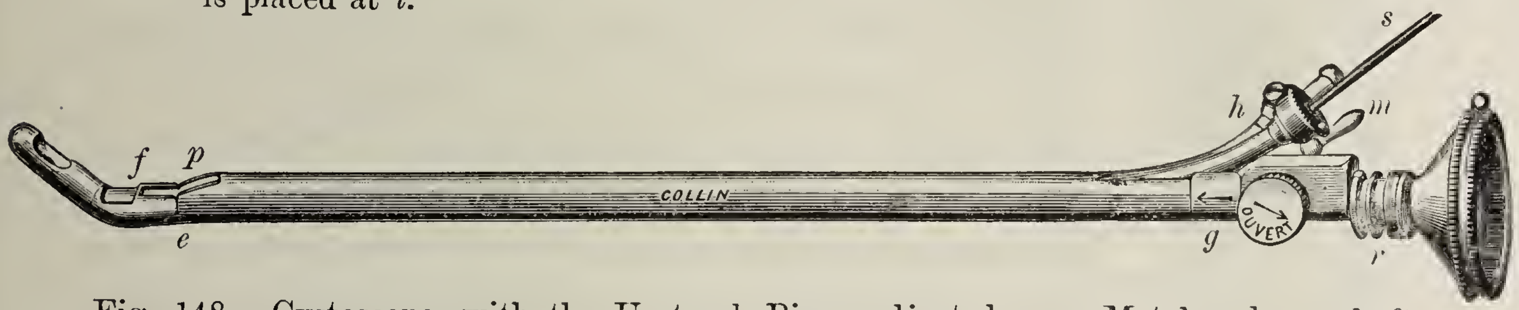

Fig. 148.—Cystoscope, with the Ureteral Piece adjusted. *e*, Metal rods or shafts which, worked by the wheel *g*, move the metal spur *f*, on which rests the catheter *s*, which, on being pushed, passes out through the opening *p* *h*, the tube conducting the ureteral catheter; *m*, adjusting screw, having inside a round piece of indiarubber pierced to let the catheter *s* pass through; *r*, irrigating canal, provided with a tap.

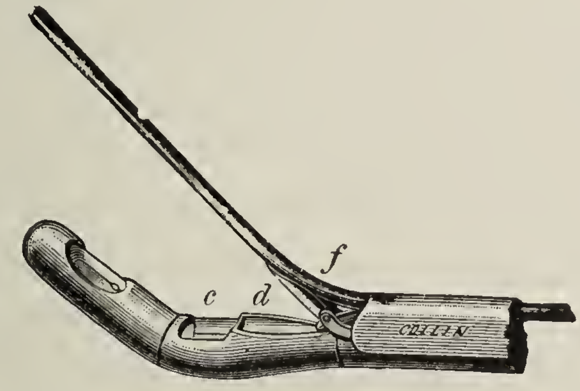

Fig. 149.—The extremity of the instrument. *d*, the opening above the prism *c*, which receives the spur at the end of the ureteral portion of the instrument. The metal spur *f* is raised, and with it the catheter.

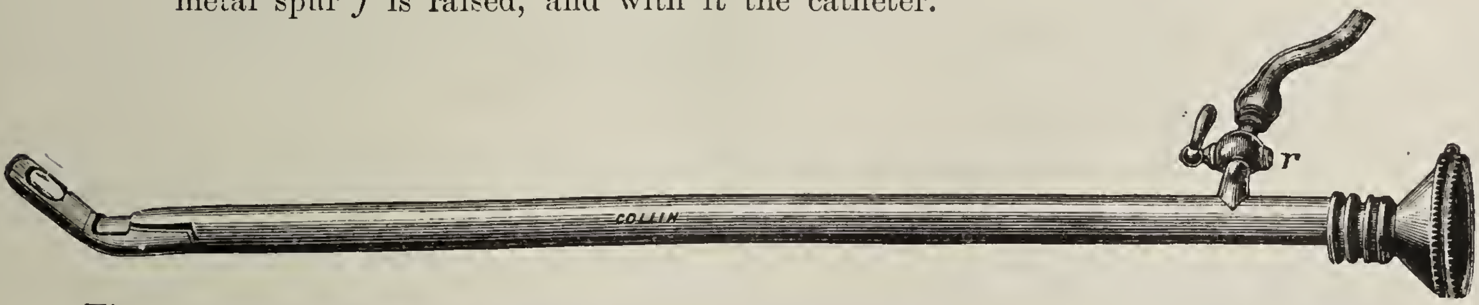

Fig. 150.—Cystoscope provided with an Irrigating Piece. *r*, the outer extremity of the irrigating canal, furnished with a stop-cock.

are very sensitive, Nitze advises that 50 cubic cm. of a 2 per cent. solution of cocaine should be previously injected, or if required, a dose of morphia should be subcutaneously administered or an anæsthetic given; but these drugs are not commonly employed or necessary.

After the irrigation is completed, 150 to 200 cubic cm. (4 to 6 ounces), if possible, of boracic solution, or a methylene blue solution, should be left in the bladder; in no case should the operation be attempted with less than 50 cubic cm. retained. Some prefer to leave in the bladder a fluid coloured with methylene blue; the urine which flows through the catheter, if from the ureter, will be uncoloured by the blue. A reliable assistant is needed to hold the ureteral catheter and keep it free of the thighs, and to give general help if irrigation is requisite or anything goes amiss with the current. The patient, if a woman, should be placed in the same position as for the introduction of the vaginal speculum.

The cystoscope, lubricated freely with glycerine or boroglyceride, is introduced according to the ordinary rules for introducing a sound or lithotrite.

As soon as the beak of the cystoscope has passed the neck of the bladder it should be tilted downwards and outwards, so as to give it an inclination of about 30° with the horizontal. The cystoscope is held in this position with the left hand, whilst the electric current is turned on with the right hand and the cystoscopic illumination thus established. This done, the ureteral orifice sometimes is seen at once; more frequently it is only brought into view after gently moving the beak of the instrument a little to the right or to the left, or pushing it a little further in, or withdrawing it a little.

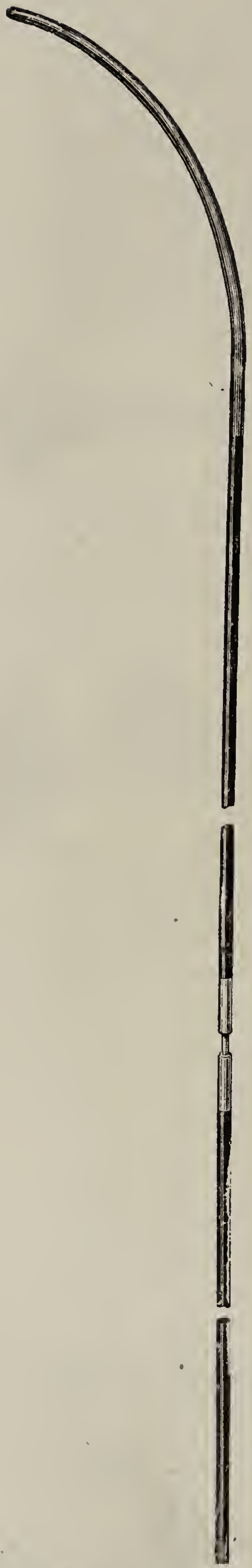
Fig. 151.—Guide Bougie for the Ureter. The end of gum elastic, the shaft of whalebone. (After Albarran.)

When the cystoscope of Albarran is so adjusted that the ureteral orifice is a little below and a little to the outside of the centre of the field, the ureteral catheter is gently pushed inwards until its extremity is visible in the illuminated area; and as the catheter approaches the ureteral orifice it is advanced or withdrawn a little, or lateralised a little by rotating the ureteral portion on the optical portion of the instrument, or the direction of the cystoscope itself, if required, can be slightly changed without losing sight of the ureteral orifice, and until the point of the catheter is exactly opposite the opening.

The catheter, having entered the ureter, is gently pushed onwards as far as it is required to go—even to the renal pelvis. It should be closely watched during its progress, for if any obstacle hinders its advance the part of the catheter within the bladder is seen to bend upon itself. The catheter can be left in the ureter, and the cystoscope removed from the bladder; but if this is to be done the catheter must be passed as far into the ureter as is required before the cystoscope is withdrawn, because after its withdrawal any further attempt to advance the catheter along the ureter ends only in the catheter doubling upon itself in the bladder.

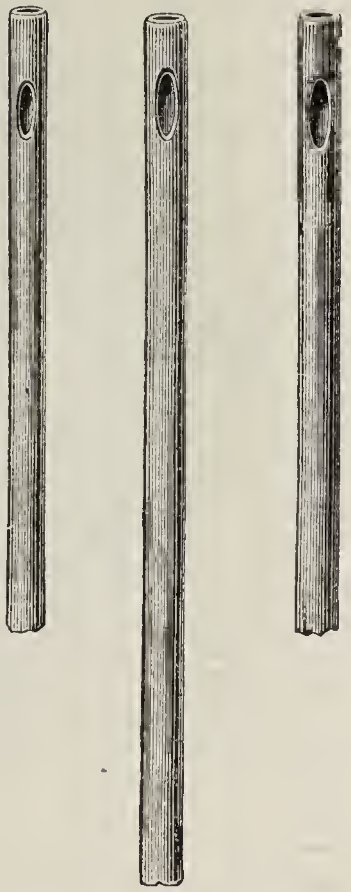

Fig. 152. — Ureteral Catheters of larger size, for passing into the Ureter upon the Guide Bougie. (After Albarran.)

The ordinary ureteral catheters are of small size. With Albarran's instrument catheters of a somewhat greater diameter, equal to No. 8 French gauge (Charrière) can be introduced. In length they are 70 cm. for men and 50 cm. for women. Some are open at the end, and have a lateral eye as well (Fig. 152). In others the end is closed and shaped like an ordinary English catheter, with an eye at the side; these are the catheters used most frequently by Albarran. Others are terminated like an olive-headed urethra catheter.

For the treatment of strictures of the ureter or of pyo-nephrosis, and for use when there is blood-clot or thick creamy pus in the tube, these sizes are too small, and therefore Albarran has applied the principle of Fergusson's "guide staff," well known to English surgeons in the treatment of certain urethral strictures, for the purpose of passing catheters from Nos. 9 to 12.

A staff of 70 cm., having the first 10 cm. flexible like an ordinary gum elastic catheter, and the remaining 60 cm. consisting of whalebone for greater resistance (Fig. 151), is conveyed in the ureter tube of the cystoscope and introduced along the ureter as far as the renal pelvis. As in the male this staff is not sufficiently long to enable it to be used as a catheter carrier, it is lengthened like a fishing-rod by screwing on, when the cystoscope is withdrawn, additional lengths of whalebone to the external extremity of the portion which has been passed into the ureter. Over this staff a No. 9 or larger catheter, with an open end, is made to glide, after having been well lubricated both inside and out. In the great number of cases, Albarran tells us, the catheter is passed in this way up the ureter quite easily.

When pushed as far as required, it is only necessary to hold the catheter with the left hand whilst with the right hand the staff is withdrawn.

If after withdrawing the staff it is desired to pass the catheter higher up the ureter, it is requisite to pass the staff again along the catheter, and then push onwards the catheter further into the ureter. The catheter of No. 9 size or larger cannot be pushed onwards except upon the guide staff, as the ureteral walls crowd over the end of the catheter and cause it to bend upon itself.

If it is desired to change a catheter *en demeure*, it is not necessary to use the cystoscope; it suffices to re-introduce the staff along the whole length of the catheter, and then withdraw the catheter, glide a new catheter over the staff, and finally withdraw the staff. It is not well to leave in a larger catheter than No. 8 at first, but the size may be gradually increased at intervals of a few days. Albarran has in this gradual manner introduced No. 13.

As to *the length of time a catheter has been retained in the ureter*, Albarran and Lluria showed in 1890, by their experiments, and their observations on a woman on whom cystotomy had been performed, that a catheter could be retained twelve days. In a case in which lumbar nephrotomy for pyo-nephrosis had previously been performed, and a fistula followed, the same catheter was left in the ureter for twenty-two days without any ill consequences;* and in 1897 Albarran showed at the Surgical Society of Paris a woman who had retained a catheter in her ureter for thirty-three consecutive days without any harm ensuing. He has kept a catheter in each ureter of a woman for three days without ill effect.

With the ureter cystoscope of Nitze the plan of procedure is as follows. It should be premised that to the cystoscope No. 2 of Nitze (that is, with the window and prism situated at the summit of the angle formed by the junction of the beak with the shaft of the instrument) the ureteral catheter is fitted, and runs in a long canal on its under surface extending from its external end to the window. The catheter is a gum elastic one, 20 to 25 inches (40 to 65 cm.) in length, one millimetre in diameter, and pierced on the side near its extremity with an eye. A flexible stylet runs in the catheter.

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* *La Semaine Médicale*, May 26th, 1897.

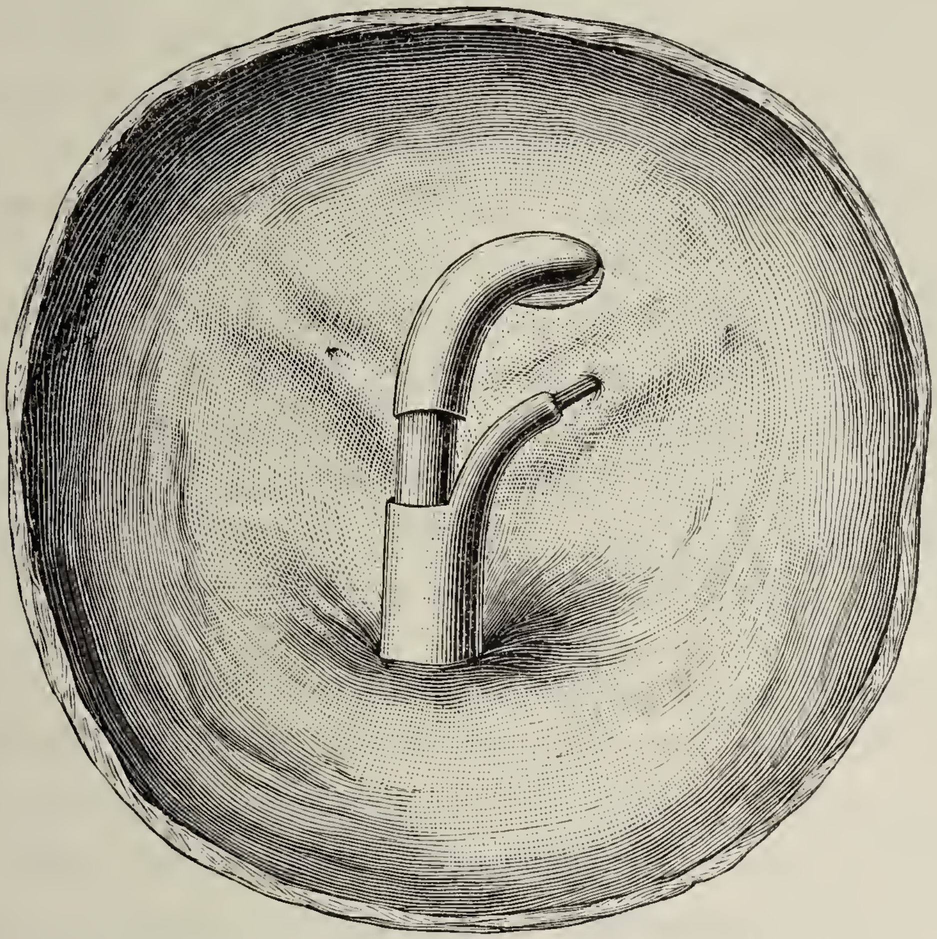

Fig. 153.—Catheterisation of Male Ureter. After Dr. Max Nitze. (*Annals of Surgery*, vol. xxii., p. 407.)

The cystoscope is introduced into the bladder, the orifice of the ureter is made evident, and the catheter conveying the stylet is pushed forwards until it reaches this orifice (Fig. 153). The operator then introduces the catheter with great gentleness into the ureter, desisting from pushing it onwards at the least resistance—it ought, like the lithotrite in the male urethra, to, so to speak, make its own way. When the catheter reaches the part of the ureter near the bony wall of the pelvis it cannot be passed further until the stylet is withdrawn. This should be done with one hand, as the catheter is passed onwards with the other hand. In this way the catheter can be made to reach the renal pelvis. Very shortly after the stylet is withdrawn the urine will most probably escape by the catheter in the manner characteristic of the flow of urine from the orifice of the ureter itself, and if methylene blue solution has been used for the bladder the fluid issuing from the catheter will be urine unstained by the coloured fluid in the bladder.

Frequently, however, the urine does not escape owing to some obstruction in the eye of the instrument.

This plugging of the catheter sometimes occurs again and again, rendering it impossible to obtain any urine from the kidney.

The requisites for catheterisation of the ureters by either Nitze's, Casper's, or Albarran's cystoscope are :—

1. A urethra of sufficient calibre to allow the passage of the instrument.

2. The bladder must be able to retain 4 to 5 ounces of water.

3. The fluid in the bladder must be kept transparent.

But there are difficulties, even when in these respects everything is favourable, which will ever render ureteral catheterisation in the male a very delicate and uncertain procedure, and will always put it beyond the power of all but a few to perform.

THE ADVANTAGES AND DISADVANTAGES OF ENDOSCOPIC AND CYSTOSCOPIC EXAMINATION AND OF URETERAL CATHETERISATION.

Endoscopic and cystoscopic examination of the ureteral orifices and catheterisation of the ureters are indicated (1) in cases in which it is doubtful whether a disease of the urinary tract is situated in the kidneys or in the lower urinary organs; (2) when it is doubtful whether both kidneys exist and are in good functional activity; (3) in cases in which we know that the disease is renal, but are uncertain as to whether it involves one or both kidneys, and if only one, which one; (4) in cases in which we are quite certain that one kidney is diseased, but are uncertain as to the state of the second kidney; (5) when it is required to break up a clot of blood or mucus impacted in and obstructing the ureter.

The surgeon experienced in renal affections, by paying due attention to the history and symptoms of a case, will generally be able to arrive at a sufficiently precise diagnosis without these instruments; but it must be allowed that there are cases—exceptional it may be—in which the information afforded by the ureteral catheter or the cystoscope will give the surgeon the clue he needs, and determine him as to the surgical treatment to adopt.

In the absence of pain, in either kidney region, and in the presence of blood or pus, or both, in the urine, a cystoscopic examination may throw light on a case (1) by revealing an abnormal state of one ureteral orifice, and of one only; (2) by disclosing the escape of pus or blood from it; (3) by the unnaturally irregular or dribbling passage of urine from it; (4) by the projection of a plug of muco-pus or blood-clot from it; (5) by the absence of any urine flowing from one ureter; and (6) by healthy urine being discharged from one ureter and unhealthy urine from the other.

In certain cases of uretero-vaginal fistula, when it is doubtful which ureter is at fault, a cystoscopic investigation, with or without ureteral catheterisation, by disclosing the fact that urine is passing into the bladder from one ureter only, gives at once conclusive evidence as to which ureter requires to be repaired. Moreover, the introduction of a bougie into the ureter as a guide to the position of the duct, is of value in certain abdominal and vaginal operations as a safeguard against wounding the ureter, and may much facilitate an operation for the cure of ureteral fistula or stenosis.

I desire, however, to protest in no uncertain manner against the routine employment of these instruments for diagnostic purposes; and to condemn emphatically ureteral catheterisation and irrigation as a mode of treating hydro- and pyo-nephrosis and ureteral stenosis. Nor ought ureteral catheterisation of the opposite ureter to be employed, as has been suggested, in every case in which nephrectomy is contemplated. I am satisfied that in most cases in which nephrectomy ought to be undertaken the other means of investigation at our disposal are sufficient to give us the security we require as to the presence and functional activity of the second kidney.

When the bladder is in a septic condition, it would be very unsafe to catheterise the ureter of the opposite kidney; and I quite agree with Edebohl* in advising an examination through a lumbar incision on each side rather than run the risk of infecting the opposite organ by the use of the ureteral catheter.

Professor Obalinski, in an address at the Eighth Congress of Polish Surgeons in 1896, expressed opinions which I have myself been in the habit for many years of teaching, that as a kidney seriously defective, remaining after the extirpation of the other kidney, may fulfil the functions of both, the differentiation of the urines of the separate kidneys is unnecessary, and is calculated to impede the development of the surgery of the kidney. On the other hand, and as an argument equally opposing routine ureteral catheterisation, we know, as Byrom Robinson has expressed it, that "disease may easily obliterate thousands of renal tufts and miles of renal tubes without giving evidence in which kidney the destruction exists." Mr. Hurry Fenwick, too, has quite candidly pointed out some of the dangers and fallacies of cystoscopic examination of the ureteral orifices.

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* *Annals of Surgery* April, 1898.

The objections to ureteral catheterisation are—

1. The obnoxious nature of the operation in the female, and the extreme difficulty of it in the male.
2. The unreliableness of the information it affords.
3 The risks to which it exposes the patient.
4. The disadvantages of it as a mode of treatment.

A few words of explanation are needed on each of these points.

1. *The positions in which women are placed,* whether the elevated dorsal or the knee pectoral, as shown by Howard Kelly's plates, are very revolting to the finer feminine sense, unless the patient is under an anæsthetic, and suffice in some instances to make her refuse to submit to a second examination; and as the time required for catheterisation of the ureter is often considerable, and when the operation is adopted as a means of treatment for ureteral stenosis or irrigation it has to be repeated every few days, and sometimes over several months, general anæsthesia is out of the question. Kelly* states that he catheterised the left ureter of a woman with stricture of the vesical end of the ureter one hundred and twenty times between March 2nd and June 2nd, 1894; that for the first three weeks of her treatment repeated vain endeavours were made to get the ureteral catheter through the stricture into the ureter; that he was obliged from time to time (six times altogether) to suspend the treatment for two or three days together on account of chill, high temperature, and other marked constitutional disturbances; and that even after this prolonged and trying treatment the stricture continued, and the ureter above the stricture remained lax and distended.

Grünfeld, with all his experience and dexterity, like Simon, found "the introduction of pliable instruments into the ureter to be often difficult on the one hand and of slight advantage on the other." Both Grünfeld, and Pozzi who had seen Grünfeld use his instrument, failed, and had to give up the attempt in certain cases.

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* "Operative Gynæcology," vol. i., pp. 438–441.

Tilden Brown,* who classifies cases into favourable, unfavourable, difficult, and impossible, points out that when the trigone of the bladder is precipitous or vertical the ureter cannot be catheterised at all; when the trigone is horizontal the procedure is not difficult. This difference however, applies more to the male than the female bladder, as it is chiefly due to the varying size of the prostrate gland.

Shoemaker † found that the mere recognition of the orifice is by no means easy when the neck of the bladder is covered with easily bleeding and exquisitely tender granulations; that many tiny depressions between granulations round about the area of the ureteral orifice greatly resemble it; and that the precise relation of the orifice to the urethra varies. He has also found that the bladder rapidly fills up with urine during inspection if previous pelvic inflammation has interfered with the mobility of the pelvic organs.

In pyo-nephrosis, thick creamy pus is sometimes smeared over the bladder mucous membrane, completely hiding the orifice, until removed by movements of the beak of the cystoscope or by irrigation.

Catheterisation of the ureters *in man* is unattended by the objection as to posture, a general anæsthetic is not needed, and pain may be subdued by previously cocainising the bladder. Meyer even states that he uses the instrument frequently in his consulting room on his male patients.

The great difficulty in effecting catheterisation of the male ureter is, however, admitted on all hands except by Albarran, who, speaking of his own instrument (which he designed in 1897), says that up to the time of writing (1899) he had succeeded in all cases, even when the prostate was hypertrophied. Skill and the knowledge of the different appearances of the ureteral orifice are, as he says, requisite; but even when thus equipped, Albarran admits that "in some cases, even when the vesical medium is clear, the ureteral orifice is only discoverable after prolonged search, and in certain patients no amount of ingenuity or skill succeeds in passing the catheter further than three or four cm. along the ureter."

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* *Annals of Surgery*, Dec., 1899.

† *Annals of Surgery*, No. 22, 1895.

W. Meyer* has sometimes been two hours at work on the same patient with the Nitze or Casper cystoscope without succeeding in his object. Either the orifice of the ureter has not been found, or it was too small to admit even the finest catheter, or the catheter has been blocked by descending blood or pus.

2. *The unreliableness of the information afforded by the cystoscope and ureteral catheterisation is shown by published and unpublished facts.*—What other conclusion is to be drawn when one of the greatest advocates of ureteral catheterisation has submitted patients to nephro-ureterectomy for what he diagnosed as tuberculous disease of the ureter, and yet when the preparations were examined by a skilled pathologist the disease in each case was pronounced to be limited to the kidney? Or again, when a distinguished cystoscopist diagnoses complete occlusion of the ureteral orifice which the subsequent course of the case after nephrectomy shows to have been patent and normal, whilst he overlooks several soft calculous masses in the bladder?

It is much safer to be guided by the general and local symptoms, by the character of the urine, and by palpation of the vagina and bladder in the female and bimanual palpation of the bladder in the male, than to trust implicitly to one's skill in the use of such instruments as the cystoscope and ureteral catheter.

Not less important, though less striking illustrations of the unreliableness of ureteral catheterisation are to be found in the fact that the urine which at first passes along the ureteral catheter is often of a brown or red colour from admixture with blood due to the mechanical lesion of the tender ureteral mucous membrane by the instrument. "There is some and often a fair amount of blood in nearly all the specimens of urine collected from the ureter by the catheter" (W. Meyer). The urine does not begin to flow through the catheter immediately upon its introduction into the ureter; it often takes a minute or two for the catheter to fill, and according to Kelly sometimes three or four minutes are required for this purpose. We see how possible it is, therefore, that a wrong conclusion may be drawn, both as to the quality of the urine and as to the functional activity of the kidney.

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* Article "Cystoscope," in "A System of Surgery of the Genito urinary Organs."

The first half drachm or more of the urine should be thrown away, and the catheter must be allowed to remain in the ureter many minutes ; a quarter of an hour or more is none too long to obtain a satisfactory sample. It has taken W. Meyer sometimes two hours to collect 4–5 cubic cm. from one kidney, and in another case he obtained no fluid at all. Again, plugs of pus, a morsel of blood coagulum, or a little detached epithelium from the ureter easily gain entrance into the lumen of these small catheters, and give rise to obstruction which repeated aspiration and washing through the catheter does not overcome ; or the flaccid mucous membrane of the ureter crowds itself into the eye, or caps the open end of the catheter and is made to swell and bleed by repeating these attempts to establish a free channel.

It is a question whether the introduction of the catheter into the ureter may not produce a reflex anuria of the kidney. At present we have no proof of this, but in the case of a young lady recently under my care, I saw drops of urine come time after time through the ureteral orifice into the bladder, yet whilst the catheter was in the ureter there was no escape of urine through it, and after withdrawing the catheter there were a few drops of blood-stained urine in the catheter, but no urine flowed from the ureter as one would expect had the urine been secreted and dammed back for several minutes. Other and much more prolonged observations of this sort are requisite, however, before we are justified in coming to the conclusion that there is a temporary suppression of secretion on the part of the kidney during catheterisation of its ureter.

3. *The risks attached to catheterisation of the ureter are :*—(*a*) Abrasion of the epithelium and bruising of the mucous membrane of the bladder and a similar injury to the ureter, resulting in the discharge of blood and epithelial *débris* in the urine. Strong enthusiast as he is for ureteral cystoscopy, Albarran admits this, for when referring to the prognosis of infectious pyelo-nephritis he says : "In urinary affections of old people the renal lesions are nearly always double, making renal infection in them to be dreaded. . . . In these cases we ought not to use the cystoscope either with or without ureteral catheterism except in cases of necessity, and then only with the greatest precautions."* The movements required may cause erosions of the mucous membrane of the ureter or of the bladder, which are the doors of entrance

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* Albarran, "Traité de Chirurgie," t. vii., p. 758.

to general infection of the blood and may cause death. (*b*) Abdominal pains, in some patients intensely severe, lasting eighteen hours or longer, and recurring after every succeeding introduction of the catheter. (*c*) Fever similar to that which occurs after catheterisation and other operations on the urethra. (*d*) Permanent occlusion of the vesical orifice of the ureter from injury inflicted by the catheter, resulting in complete destruction of the corresponding kidney and nephrectomy. (*e*) Ascending septic infection of the ureter and kidney by the transference of micro-organisms with the catheter from the bladder. (*f*) Breaking a catheter and leaving a portion in the ureter. Pawlik was able to empty a hydro-nephrosis and to leave in a permanent catheter, but, adds Pozzi, this is not without danger. The metal end of a gum-elastic catheter came off, and was extracted only by means of a happy combination of circumstances.

4. *Imperfections as a method of treatment.*—As a mode of treating strictures of the ureter and relieving or curing distensions of the renal pelvis catheterisation is unsurgical, unscientific, difficult, tedious, and ultimately only partly efficacious, if not absolutely useless. It ought to meet with complete condemnation. It counts for little in the general treatment of these cases that one surgeon can produce a case of ureteral stricture which after 120 or more introductions of the catheter he has dilated up to the extent which the minute vesical orifice of the ureter will admit; or that another surgeon has emptied a hydro-nephrotic sac which was threatening to rupture; or that a third has repeatedly irrigated and is supposed to have cured a pyo-nephrosis. Such individual cases, even if the results were all that could be desired, are a very inadequate set-off against *the tediousness of the treatment, the pain and distress it causes to the patient,* and the danger and suffering to which other patients will become exposed at the hands of the adventurous or ambitious but inexperienced, who will try their hands at these instruments if the treatment should receive the sanction of the teachers of our profession.

To my thinking, even if the obstruction is near or actually at the ureteral orifice, it is unpardonable to recommend the slow drainage of a hydro-nephrotic kidney by a process which is so obnoxious to the female and so difficult in the male as ureteral catheterisation, especially as the same end can be obtained as safely or more safely, and much more expeditiously, by a lumbar incision. Moreover, by the lumbar incision the surgeon is able to inspect the renal pelvis and the upper part of the ureter, and to test with the bougie the whole length of the canal for the cause of the obstruction, many of which causes are remediable by a plastic operation or a ureterotomy. Even when the cause of obstruction is at or near the vesical end of the ureter, if it be something other than a stone and not removable, uretero-vesical grafting is the operation of choice.

The treatment of pyo-nephrosis by ureteral catheterisation and irrigation is even more improper. If a case of pyelitis or pyo-nephrosis is severe enough to lead a patient to submit to this objectionable treatment, it is severe enough to be treated, irrigated, and drained through the loin. Mild cases may be left to medicinal treatment, good air, proper diet, and time—if there is no local cause such as a calculus, which can be extracted. Other cases need to be more directly and immediately dealt with than through a flexible tube from 20 to 30 inches long, and not larger than, if anything like so large as, a slim wheat straw. In many instances of pyo-nephrosis, calculous and otherwise, which I have operated upon, the calyces have been stuffed with putty-like masses of pus and old, partially disorganised blood-clot, portions of which were firmly adherent to their walls, and which, if detached, could not possibly pass through such a tube, be the perseverance of the surgeon in irrigating and the endurance of the patient in suffering the attempts never so great.

As to stenosis and strictures of the ureter, the bougies capable of being used with safety are too small to be efficient, and if larger tubes are used, as Albarran suggests, the ureteral orifice becomes over-stretched and loses its valve-like function, and the kidney is exposed to the risks of ascending septic infection if the bladder is not and does not remain pure, and to the additional obstruction of the back pressure of the urine. Besides, our knowledge of the tendency of urethral strictures to contract after treatment by simple dilatation ought to teach us what to expect from similar treatment with less effectual instruments when employed on the ureter.

A valuable discussion on the employment of the ureteral catheter as a therapeutical measure was introduced by L. Casper at the Berlin Medical Society in 1898.* Casper reported three cases in which he claimed success for the treatment. The practice was unfavourably criticised by Kütner and Israel.

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* Soc. Med. Berlin, Nov. and Dec., 1898, *Sem. Médicale*, Dec., 1898.

CHAPTER IV.

INJURIES OF THE URETER.*

INJURIES to the ureter are exceptionally rare, if we exclude those which occasionally happen in the course of certain surgical operations on the abdominal or pelvic viscera. Its small size, its deep position, the fact that in one-half of its extent it is protected by the bony wall of the pelvis, its loose connections whereby it is able to move freely upon the structures behind it, together with its own elasticity, serve to explain this exemption from injury.

In 1884, when writing on "Rupture of the Ureter,"† I stated that there was no occasion to consider it apart from rupture of the kidney, because in the very few cases on record the rupture of the ureter was quite close to the renal pelvis, and it was neither practicable nor requisite from the point of view of treatment to distinguish between subcutaneous rupture of the renal pelvis and subcutaneous rupture of the ureter.

With reference to "Penetrating Wounds of the Ureter," I therein pointed out that, except the gunshot wound of the ureter which happened to the Archbishop of Paris in 1848,‡ and the doubtful case recorded by Hennen in 1818,§ there existed no published report of a penetrating wound of the ureter alone, unless we accept Holmes's very doubtful case as such.‖

No case of penetrating wound is reported to have occurred in the War of the American Rebellion; and when we recall the thoroughness with which the surgical history of that war was prepared, this fact alone shows the extreme rarity of such injury. The conclusion I formerly arrived at was that the diagnosis, symptoms, sequelæ, and treatment of injured ureter in no way differed from those of ruptured or wounded kidney.

These remarks were based upon a careful perusal of the reports of thirteen cases described as subcutaneous injuries, and upon the three cases above mentioned of penetrating wounds. The cases were all that I was at that time able to discover, after a fairly laborious search through the literature of wounds and other injuries of the abdominal viscera.

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* This chapter has been published, substantially in the same form, as an addendum to my "Hunterian Lectures."

† "Surgical Diseases of the Kidney."

‡ *Gaz. d. Hôp.*, Paris, 1848.

§ "Military Surgery," 3rd edition, p. 430, case 72.

‖ *Med.-Chir. Trans. Lond.*, vols. lx. and lxv.

Two of the cases of subcutaneous injuries had been under my own personal observation. As dresser to Mr. Hilton, I was responsible for the notes of his case, which was one of rupture of the kidney, not, as Poland described it and others have quoted it, of rupture of the ureter; and, as house surgeon at Guy's Hospital at the time, I daily watched Mr. Poland's case, which was really one of ruptured ureter.

Since 1885 only eight cases, so far as I am aware, have been published purporting to be subcutaneous injuries of the ureter, namely, by Godlee, 1887; Chaput, 1889; Le Dentu, 1889; Coull Mackenzie, 1891; Allingham, 1891; Fenger, 1894; Page, 1894; Morris, *Clinical Journal*, 1894; *Edinburgh Medical Journal*, January, 1898. These are not, however, all cases of injury to the ureter proper, and they do not supply any grounds for altering the conclusions based upon earlier cases.

In view, however, of the growing importance attached to the surgery of the ureter, it is well to describe the injuries of the ureter and the operations performed and suggested for their relief, apart from those relating to the kidney.

The injuries involving the ureter depend very much as to their symptoms and gravity upon whether they are subcutaneous or open, extra- or intra-peritoneal. They may be conveniently considered under three classes:—

I. Subparietal injuries; or those in which no open wound communicates with the injured ureter.

II. Penetrating wounds; or those in which an open wound communicates with the injured ureter.

III. Surgical wounds, accidentally or intentionally inflicted, including those which are caused by the use of obstetric instruments, or following gangrene due to difficult or prolonged labour.

Those which result from gangrene and from surgical accidents come necessarily for consideration under Ureteral Fistula; whilst those made intentionally by the surgeon come under Operations upon the Ureter.

In all three classes the peritoneum may or may not be involved. In Class I., as a rule, it is not; in Class II., it is most likely to be; whilst in the accidental wounds of Class III., excepting those produced by obstetric instruments, it almost always is.

CLASS I.

SUBCUTANEOUS INJURIES OF THE URETER.

Twenty-four cases are now scattered through surgical literature which have been repeatedly mentioned by writers as subcutaneous injuries of the ureter; but a close examination of the details given of them shows that twelve at least are injuries of the parenchyma or pelvis of the kidney, not of the ureter proper, and there is considerable room for doubt as to the exact nature of the injury in several of the others. The explanation of the fact that cases of ruptured renal pelvis are so often described as ruptured ureter is due to the want of uniformity in the use of terms. The ureter in anatomical works is described as commencing at the renal pelvis; but the term "renal pelvis" is often used as if it were synonymous with hilum of the kidney, instead of that dilated part of the renal duct which extends from the union of the calyces to the upper end of the ureter proper. The ureter proper commences nearly in a horizontal line with the lower extremity of the kidney.

The following is a list of the twenty-four cases to be found in surgical literature described as "rupture of the ureter." Thirteen of them were more or less fully quoted in my book on the kidney in 1885. Eight have been published since. Three had been overlooked by me, namely, those by Joel, Cabot, and Bardenheuer. The whole twenty-four cases are arranged below in four different groups.

(A) Verified cases of rupture of the ureter—(1) Poland (with extra-peritoneal extravasation and tumour), (2) Coull Mackenzie (with intra-peritoneal extravasation, but no tumour), (3) Morris.

(B) Probable rupture of ureter with extravasation—(1) Stanley (boy), (2) Godlee, (3) Chaput, (4) Page.

(C) Contracted ureter, with hydro-nephrosis, or other renal changes, possibly due to ureteral injury—(1) Haviland, (2) Pye-Smith, (3) Soller, (4) Cabot, (5) Fenger.

(D) Not injuries of the ureter proper, but rupture of renal pelvis or renal substance, opening calyces and giving rise to extravasation—(1) Stanley (female), (2) Hilton, (3) Hicks, (4) Barker, (5) Bardenheuer, (6) Dumenil, (7) Joel, (8) Allingham, (9) Harrison (two), (10) Croft, (11) Bennett May.

Besides the above, Dr. W. J. Collins* has published two cases of traumatic hydro-nephrosis, in which the injury may have been either to the ureter or to the renal pelvis. Dr. Collins thought that the most plausible explanation of one of these cases was occlusion of the ureter, from contraction following bruising at the time the child, aged five, was run over; or else compression by blood, or by callus thrown out around a fracture of the pelvis. In neither case was there any direct evidence as to the cause of the hydro-nephrosis.

Of the twenty-four cases we find, as I have said, only twelve that can be considered injuries of the ureter proper, and of these only three were actually proved to be ruptures of the ureter. One of the two (Coull Mackenzie's) was an undoubted case of intra-peritoneal laceration; in another (Poland's) the ureter was torn across behind the peritoneum. In both these cases the nature of the injuries was verified by post-mortem examination. In the third case (Morris's) a rent in the renal pelvis was found when letting out the extravasated urine on the twenty-sixth day after the injury, and the torn ureter was discovered when performing ureterectomy ten years after the injury.

In five cases (Group C) a tumour was formed by alteration in the kidney itself. In four of these, contraction or obliteration of the ureter followed the injury, and after a long time a renal tumour developed; in three of them the condition was ascertained by post-mortem examination to be—in one, pyo-nephrosis with atrophy and impermeability of the ureter (Haviland's); in another, pyo-nephrosis (which had at one time communicated with the colon), with the ureter contracted at a point one inch and a half from its commencement, so as scarcely to admit the smallest probe (Pye-Smith's); and in the third the kidney was converted into a large polycystic tumour, and the ureter in the middle of its course was almost obliterated (Soller). In the fourth case the ureter was strictured, and an intermittent hydro-nephrosis developed ten years after the injury. The stricture had existed for twenty-four years when Fenger performed ureterotomy from the loin. He divided the stricture, and closed the wound in the ureter by longitudinal sutures, after the Heinecke-Mikulicz method for the treatment of pyloric stricture. The patient recovered, and had no return of the hydro-nephrosis. In the fifth case (Cabot) the nature of the obstruction and its precise situation was not ascertained. It is described by Cabot as one of "nephrotomy for hydronephrosis," and resulted in recovery. The swelling developed "several weeks" after a fall, and it seems to me highly probable that the obstruction was only partial and temporary, and was caused by blood-clot, either in the renal pelvis or in the ureter, which subsequently became absorbed or passed on into the bladder.

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* *Brit. Med. Journ.*, April 30, 1892

In Haviland's case the injury was received four years before the tumour developed, in Pye-Smith's two years, in Soller's nine, and in Fenger's ten years before. It is very doubtful whether the condition of the ureter in Haviland's and Soller's cases was not due to causes other than injury.

In six cases, namely, those included in Group B, and in Poland's case and my own, a tumour was formed by a collection of fluid behind the peritoneum.

In none of those in Group B was the precise source of the extravasation ascertained. Stanley's case was that of a boy in many respects precisely like Croft's and Bennett May's and others, where the injury was supposed or ascertained to have implicated the renal pelvis and not the ureter.

There is also much room for doubt as to whether the ureter proper was injured in Godlee's case. It is more than probable that the injury was to the renal pelvis, but that it could not be discovered at the time of the nephrotomy, nor, owing to the difficulty in separating the kidney from the surrounding tissues, at the subsequent nephrectomy. We cannot, however, exclude either of these cases from the list of injuries to the ureter. The two other cases in this group (Chaput's and Page's) are most probably veritable injuries of the ureter proper.

Chaput's case is exceptional in that the cæcum was ruptured on its posterior aspect, and the extravasated urine not only accumulated in the retro-peritoneal tissue, but entered the cæcum through the rupture in its wall, and distended this and the neighbouring colon so as to create a very misleading abdominal tumour.

In three of these cases (Godlee's, Chaput's, and Page's), an incision, followed by drainage of the retro-peritoneal space, was practised, and in Godlee's case evacuation had been effected before the lumbar incision was made. In each of these three cases nephrectomy was subsequently and successfully resorted to, because of pyrexial attacks due to suppuration of the kidney, and to the persistence of a fistula.

In Page's case the incision was made in the linea semilunaris, and drainage was effected through this. In Chaput's case, as well as in Godlee's, the incision and drainage were through the loin.

Poland's case, in which a tumour formed behind the peritoneum, is allied to the four cases just mentioned, though it differs from them in some most important particulars. As the accident resulted in death on the sixth day, the exact nature of the injury was ascertained by post-mortem examination.

Poland describes the ureter as torn quite across, just below the renal pelvis; and its broken end, together with the kidney, was surrounded by the half-sloughy, putrescent, and jelly-like tissues behind the peritoneum. The kidney itself was injured, its capsule being separated from it by extravasated blood; the renal capsule prevented this blood-clot from mixing with the urine extravasated through the torn ureter. The right lumbar region was raised in a great swelling, from effusion of blood. In my own case twenty-six days elapsed after the injury, and then a large retro-peritoneal swelling, containing over one hundred ounces of slightly blood-stained urine, rapidly formed.

It is unnecessary to analyse the twelve cases in Group D, which have been often quoted as subcutaneous injuries of the ureter, but which in reality are not so. It will suffice to give a list of these, with the dates and references to them. This is done at the end of this chapter.

We will now summarise the result of a careful analysis of the twelve cases above mentioned, with the view of arriving at the causes, pathology, symptoms, and treatment of ureteral subcutaneous injuries.

Etiology.—Of the twelve cases above enumerated, forcible compression between two hard bodies at the level of the umbilicus and loin was the form of the violence inflicted in three; kicks from horses in two (Chaput's and Pye-Smith's); the passage of the wheel of a carriage over the trunk in two (Godlee's and Page's); falling from a van and striking the loin againt one of the wheels, in my case; falling on to the back from a height in one (Haviland's); falling down stairs in one (Cabot's); the bursting of a cannon shell in one (Soller's); and a violent jerk in jumping from a horse in one (Fenger's). It is noteworthy that in both the cases in which the peritoneum was ruptured (Poland's and Coull Mackenzie's) the form of violence was forcible compression of the trunk—between the platform and a railway carriage in one, and between two heavy trucks in the other.

Tuffier has suggested that the ureter gives way by being crushed against the tip of the transverse process of the first lumbar vertebra. This may be the method by which the renal pelvis more often is torn, opposite the hilum of the kidney; but the ureter only commences a little above the level of the tip of the transverse process of the third lumbar vertebra, too low down, therefore, to be crushed against the first transverse process, though it may be so compressed against the tips of the third, fourth, or fifth processes. In Poland's fatal case, in which the ureter at its junction with the renal pelvis was torn right across, the transverse processes of the three upper lumbar vertebræ on both sides were broken off, and the twelfth rib on each side was fractured.

Le Dentu thinks a veritable tear of the ureter may be caused by the sudden and violent downward displacement of the kidney, the weight of which drags forcibly upon the ureter at its junction with the renal pelvis, or at some point lower down than this, namely, at the level at which the ureter retains, during the shock, its normal attachments.

As the kidney is under cover of the lower ribs, and the lower half of the ureter is protected by the bones of the pelvis, it would seem that any great violence, applied either from in front or from behind, will tend to stretch the ureter most severely at one or other extremity of its abdominal course, whilst the intervening portion will escape with the rest of the soft structures in the ilio-costal space. The holdfast influence of the kidney above, and the resistance of the brim of the pelvis below, would thus tend to the giving way of the ureter at its junction with the renal pelvis, or just above the place where it passes over the sacro-iliac synchondrosis.

The fact that in six out of twelve cases the injury was brought about by violent compression of the trunk in the antero-posterior axis, and in a seventh case (Fenger's) was caused by overstretching, gives support to this theory.

The intimate adhesion of the ureter to the peritoneum, the readiness with which it becomes detached with the peritoneum when the latter is torn away from its connections, and the fixation of the peritoneum to the spinal column, make it probable that the peritoneum will yield just externally to the line of fixation to the spine rather than that the ureter will give way. Possibly this is what really happens, and thus the ureter escapes.

The fact that the peritoneum over the ureter was injured in only one case out of twelve, and that in five cases out of eleven there was a large retro-peritoneal accumulation of urine, without the peritoneum giving way, suggests that in the rare instances when the ureter is ruptured there is less than the normal adherence between the ureter and the peritoneum.

Perhaps this helps to explain the greater frequency with which subcutaneous rupture of the ureter occurs in young life; thus, of eleven cases in which the ages of the patients are given, only two were over thirty, one was thirty, one was between twenty and thirty, four were between four and ten years of age, and three were between ten and sixteen.

The ages at which the accidents happened were four, five, nine, ten, thirteen, fourteen, sixteen, twenty-two, thirty, thirty-three, thirty-six.

Pathology.—The actual nature of the injury inflicted on the ureter can only for the most part be imagined, because in only three cases has it been actually seen. In Poland's patient, who died 135 hours after the accident, the ureter was torn right across below the pelvis of the kidney. The kidney itself was much damaged. In Mackenzie's case there were two small ruptures in the ureter, each of the size of a pea, communicating with the peritoneal cavity. In my own case the renal pelvis was laid open, and the ureter torn across just below the renal pelvis.

In two of these cases the peritoneum was torn; but only in one (Coull Mackenzie's) did the rent in the serous membrane allow of the entrance of urine into the peritoneal cavity, and in that case death ensued from peritonitis within twenty-four hours of the accident. In Poland's case the rupture of the peritoneum was on the anterior wall of the abdomen, and quite distinct from the ureteral injury; the patient died from exhaustion due to vomiting, but there was no peritonitis.

In Mackenzie's case, in which the whole of the peritoneum was described as being highly inflamed, and the intestines matted together by lymph, it is to be regretted that we have no information as to the character of the urine. We know the peritoneum is tolerant of healthy urine; it was probably the admixture of blood with the urine in the peritoneal cavity that caused the fatal peritonitis.

In five cases (out of the nine of which we have no precise knowledge of the exact nature of the injury inflicted) it is necessary to assume that the ureter was more or less completely torn across, or else lacerated in a longitudinal direction, in order to explain the extravasation of urine into the retro-peritoneal cellular tissue. In those instances where the ureter was found constricted or obliterated, some long time after an injury, one of several things may have happened. The ureter may, in the first instance, have been simply contused, or its wall may have been only partly torn through, and subsequently have undergone cicatricial contraction, or occlusion; or the cellular tissues around it may have been the seat of the injury, and the constriction of the ureter may have been the consequence of the subsequent inflammatory changes in those tissues, or of compression by blood-clot on its exterior; or, again, the narrowing may have been the result of hæmorrhage from the kidney, and the impaction and subsequent organisation of a blood-clot in the ureter, the changes in which, after a time, may or may not have allowed of the passage of urine.

But however this may be, the inference is obvious, that if the coats of the ureter are completely torn through, and the peritoneum is intact, a tumour will sooner or later be formed by the accumulation of urine in the retro-peritoneal tissue; whereas, if the ureter, from direct or indirect injury, becomes imperfectly obliterated, a tumour will in course of time be formed consisting of one or other of the varieties of obstructed kidney, namely, renal abscess, hæmato-nephrosis, pyo-nephrosis, hydro-nephrosis, or, as in Soller's case, a polycystic kidney.

If the ureter were to be at once completely obstructed by blood-clot, and permanently remained so, the result to be expected would be atrophy of the kidney. Yet that this does not necessarily follow is shown by the post-mortem examination on a man of thirty-six, whose right kidney was ruptured by the kick of a horse. In this case (recorded by Mr. Holmes *) the ureter, renal pelvis, and calyces were found plugged with blood-clot eighteen months after the kidney had been ruptured; the clot in the interior of the kidney communicated with a mass in the perinephric cellular tissue, and the line of rupture could be faintly traced through

* *Trans. Path. Soc. Lond.*, 1860. vol. xi., p. 140.

the substance of the gland, which was quite healed. Both kidneys were small, granular, and cystic, and had probably been so for a year or two before the accident. There was no marked difference in the size and general appearance of the two kidneys.

In two of the twelve cases under consideration, a communication was formed between the urine cavity and the large bowel; in Pye-Smith's case the colon was, at the post-mortem examination, found adherent to the pyo-nephrotic cyst, but the communication had become closed. In Chaput's case, a rupture of the posterior wall of the cæcum allowed of a communication between the bowel and a large retro-peritoneal collection of urine.

Symptoms.—The manifestations of subcutaneous rupture of the ureter are not characteristic. For a time there may be no sign whatever beyond the pain and tenderness caused by the injury. It is only by the subsequent development of symptoms that we are able to learn that any damage has been done to the urinary system, and not even then are we able to say at once whether it affects the renal parenchyma, the renal pelvis, or the ureter.

The urine: hœmaturia.—There may be no immediate indication in the urine of any kind whatever. Hæmaturia may be entirely absent, the urine being passed naturally and freely, as in Stanley's, Godlee's, Chaput's and my own cases; or slight hæmaturia, of a more or less transient character, may be observed, as in Page's patient, who after the second day passed at intervals small quantities of blood with the urine; or there may be well-marked hæmaturia, as in Cabot's case, in which there was bloody urine for three or four days; or as in Pye-Smith's patient, who had hæmaturia for several days after the injury.

If the ureter alone is ruptured it is not likely that the hæmaturia will be very considerable or prolonged. But slight hæmaturia, or even the absence of hæmorrhage, is in no way characteristic of ureteral as distinguished from renal injury, because many cases prove that there may be but little or no blood whatever in the urine, even though the renal pelvis or the renal parenchyma be wounded.

If, besides injury to the ureter, one or both kidneys are seriously damaged, there may be incomplete or complete suppression of urine. Thus, in Poland's case there was thrombosis of all the vessels of the opposite kidney, as well as severe damage to the kidney on the side of the torn ureter—very little urine indeed was passed during the few days the patient lived.

Pain.—A common immediate symptom is pain and tenderness at the part injured. The pain may be referred to the loin, to the front of the abdomen, to the umbilicus, or to the middle of Poupart's ligament. This pain may pass off in a day or two and the patient may remain quite free, till fresh pain is caused by the development of a tumour. Transient collapse and vomiting may occur.

Tumour.—In some of the cases (Stanley's, Poland's, and Godlee's) there was ecchymosis over the loin, abdomen, and inguinal region, and in Stanley's there was extensive suppuration of the cellular tissue about the loin and sacrum. If the patient survives the injury, a swelling will form on the injured side of the abdomen, or in the corresponding flank, within a period varying from a few days to several years.

The abdominal swelling may be caused by a collection either of urine or of urine and blood behind the peritoneum, or by one or other of the changes which supervene in the kidney itself. If due to a retro-peritoneal collection, the swelling forms much earlier than when due to change in the kidney itself; appearing usually within a few days or weeks in the first event, but only within "many weeks," months, or even years in the latter.

Of the six instances in which the swelling was *behind the peritoneum*, it appeared within a day or two in Poland's case, at the end of the sixth week in Stanley's, on the twenty-sixth day in my case, and within two or three weeks in the others.

The swelling is usually well defined, palpable from the loin and front of the abdomen, and is round, oblong, or sausage-shaped. It may extend from the thorax into the false pelvis, and may reach the median line of the abdomen.

The length of time which elapses before the appearance of this tumour, depends upon (1) the character of the rupture; (2) the degree of resistance to the escape of urine offered by the tissue into which it passes; and (3) the interference—caused by the shock or by damage—with the secreting capacity of the kidney.

The rent in the ureter may be very small, or, on the other hand, the tube may be torn right across. If separation is complete, the ends may possibly be curled up, as Tuffier states was the case in some of his experiments on dogs. Such a condition would offer an obstacle to the escape of urine; it was not, however, found to have occurred in Poland's case, in which the tear was complete, and the ends separated.

A much more likely obstacle will be blood clotted over the orifice, or around the torn end of the tube. Blood-clot may fill the calyces and pelvis of the kidney; or the parenchyma of the kidney may be compressed by blood extravasated beneath the capsule; or the renal vessels may be thrombosed. Under any of these circumstances, urine would fail to escape or even to be secreted.

Again, the cellular tissue may be very dense and not easily opened up, or its meshes may be packed with extravasated blood, and thus much opposition be offered to infiltration of urine. The shock of the accident, and the reflex suppression of urine following the injury, would explain only a certain amount of delay.

In injury to the ureter, as in injury to the renal pelvis, it is possible that the escape of urine may only follow the sloughing out of severely bruised tissue, and not take place as an immediate consequence of the original violence.

When the lesion occurs *on the peritoneal aspect* of the ureter, it is to be expected that the escape of urine will be early and profuse, as there is then less resistance to the outflow of urine; and no tumour will be likely to form in the flank.

As soon as the urine, or urine and blood, which have collected in the retro-peritoneal space decompose, inflammation, suppuration, or sloughing occurs, and other symptoms then arise, namely, increased pain, redness of the skin in the loin, œdema of the abdominal wall, elevation of temperature to 101° or 102° or even a degree or two higher, rigors, furred tongue, loss of appetite, and constipation or diarrhœa.

In both cases (Chaput's and Pye-Smith's) in which a communication between the bowel and the urine cyst was found to have existed, diarrhœa or simulated diarrhœa was a noticeable symptom.

The fluid drawn off from the tumour before suppuration has commenced, has the characters more or less pronounced of urine in colour, odour and composition; but it is generally slightly alkaline in reaction, of a low specific gravity, *e.g.* 1008 to 1010, and contains very little, perhaps only a mere trace of urea. It will probably also contain a small quantity of albumen, a little blood, and most likely a considerable amount of chloride of sodium. When the parts become septic, the fluid withdrawn will also contain more or less pus.

In Chaput's case the fluid withdrawn on the twelfth and fourteenth days after the injury was sanguinolent, and showed fatty globules, altered leucocytes, and red blood corpuscles, and was thought to be the fluid of a hæmatoma on its way to suppuration.

In the five cases in which the swelling was *in the kidney itself*, the tumour was noticed at very different lengths of time after the injury. In one case it is stated to have been "several weeks;" in others it was two years, four years, and nine years respectively. In Fenger's case, ten years elapsed between injury and hydro-nephrosis, and thirty-four years between the injury and the ureterotomy by which the intermittent hydro-nephrosis was remedied.

The nature of the renal tumour was very different in these five cases. One was an abscess-like dilatation of each of the calyces (Haviland's); one a pyo-nephrosis, the contained fluid being opaque and reddish and loaded with pus and blood cells (Pye-Smith's); in another (Soller's) it was a large polycystic kidney; in Cabot's and Fenger's cases the condition was described as hydro-nephrosis.

Occurring at such long intervals after the accident, and with the intervening period between the injury and the formation of the renal tumour perhaps absolutely without symptoms of any kind, these cases come to have importance clinically less in relation to injuries of the ureter than to renal enlargements generally.

Diagnosis.—If there is at first little or no hæmaturia and no swelling in the loin, and then after three or four weeks, more or less, a swelling forms behind the peritoneum, rupture of the ureter may be suspected. If, many months or even years after an injury in the region of the ureter, a tumour of the kidney is formed, though there has been an absence of other symptoms, or only slight hæmaturia at the time of the injury, there will be ground for suspecting traumatic contraction or occlusion of the ureter.

It is, however, impossible to distinguish injured ureter with extravasation from injured renal pelvis with extravasation; injured ureter with complete obstruction by clot or recurved ends is equally indistinguishable from injured kidney with clot plugging the renal pelvis or the ureter. Nor is this impossibility of exact diagnosis of any practical importance, because the treatment must be the same.

Some assistance may perhaps be obtained where an opening in the ureter is believed to exist, by distending the bladder with water. Kammerer found that the water escaped by the defective ureter until the bladder was quite distended, and then, doubtless, through closure of the valvular entrance in the bladder, the water ceased to flow. Le Fort and Page applied this test in their cases, but without effect.

M. Tuffier thinks that a constant escape of urine after a wound of the ureter is the leading distinction between these injuries and wounds of the kidney. Wound of the kidney will cicatrise easily and rapidly, and give rise to no extravasation of urine, whilst wounds of the ureter have no tendency to natural cure. If by "wounds of the kidney" Tuffier means also wounds of the renal pelvis, and wounds opening the calyces through the renal parenchyma, facts are against him. Recorded cases of injured kidney prove that a tumour in the loin following the injury affords no diagnostic sign between renal and ureteral injuries.

Prognosis.—In cases not complicated with other serious injuries, the immediate effect of these accidents is not to endanger life, if the peritoneum is uninjured. If prompt and decided surgical treatment were adopted the consequences to the kidney itself would be less unfavourable; and subsequent nephrectomy would probably be less frequently required than has been the case hitherto.

When the peritoneum is involved the outlook is most serious; in both the fatal cases the peritoneum was injured, and in one of them the cause of death was peritonitis. In the other case the wound in the peritoneum was not in the neighbourhood of the kidney and ureter, and no evidence of peritonitis was found at the post-mortem examination.

Treatment.—The ideal treatment for subcutaneous rupture, whether in a longitudinal or transverse direction, is immediate suture or anastomosis of the ureter, according to the character of the wound. But it is useless to state that this is the treatment at once to adopt, when the indications of the exact injury do not occur until weeks after the rupture has taken place; when there is nothing even then to indicate the site of the rupture, and when the retro-peritoneal tissues have become changed by the pressure and inflammation caused by the extravasated fluid.

Puncture of the retro-peritoneal cyst has been adopted, but with uncertain results. Stanley's doubtful case was tapped six times, and yet the tumour recurred again and again, and persisted as long as the boy was under observation. We must remember, however, that a repetition of punctures has been followed by the complete and permanent disappearance of the swelling in cases of retro-peritoneal extravasation due to rupture of the kidney or renal pelvis, and also in cases of traumatic hydro-nephrosis. Whilst in some of these cases in which the tumour ceased to refill, the ureter may have become patent, it is probable that in most of them the kidney became atrophied and ceased to secrete -- a result which cannot be regarded as satisfactory.

Lumbar incision.—A free incision in the ilio-costal space will secure the complete evacuation of the extravasated fluid; and drainage will obviate the reaccumulation of urine subsequently escaping through the ruptured tube. If the ureter is not completely torn across, the experience afforded by ureterotomy for the removal of calculi from its upper end might lead one to expect ultimate cicatrisation of the wound, and the re-establishment of the ureteral channel to the kidney.

Through this incision it will be possible to explore the renal pelvis, and if the integrity of the kidney indicates that the urine has escaped at some point in the ureter, and not from the kidney, the loin incision may be prolonged in a direction towards Poupart's ligament, passing about a finger's breadth in front of the anterior superior spine of the ilium. It will no doubt be very difficult to trace the ureter in tissues which have been changed in structure and when its normal position is disturbed in consequence of the previous extravasation. The search, however, may be somewhat facilitated by remembering that the ureter, like the kidney itself, is carried forward with the detached peritoneum; and that it is intimately attached to that membrane about half an inch, or a little more, externally to where the peritoneum is tied down to the side of the spinal column. If a rent in the ureter should happen to be found, it should be repaired by suture.

In none of the cases, however, which have hitherto been operated upon has the site of the injury been ascertained. Page says that the thought of closing the wound by suture occurred to him when he laid the cyst open, but the portion of the ureter visible was intact, and as it coursed away from the region of the kidney he did not think it desirable to follow it.

It is to be expected, however, that by a more extensive parietal incision, and a freer search for the rupture, with the aid of the ureteral catheter, the actual wound may be found and directly treated in future cases.

The proposal to apply an aseptic ligature to the torn upper end, with the object of inducing atrophy of the kidney, is to my mind very unsurgical. If the rent can be closed by sutures, so as to restore the continuity of the ureteral channel, this should be done. If the rupture cannot be found, the loin incision followed by drainage will put the damaged parts into the most favourable condition for repair. We have abundant evidence that wounds of the renal substance and renal pelvis, and also of the ureter itself, made by the surgeon for removing calculi, will ultimately heal without the aid of sutures. It should be the surgeon's object, therefore, to put accidental wounds of the ureter which he cannot localise, and therefore cannot suture, under the same conditions favourable to cicatrisation as he places wounds of his own making in operations on the kidney.

If the ureter is completely torn asunder, and its ends can be approximated, they should be united by one of the recognised methods of ureteral anastomosis or grafting. If its ends cannot be joined together, then a permanent fistula opening on the loin is the result to be expected. Such a fistula, by saving the integrity of the kidney, would be the means of preserving the patient's life, if his other kidney happened to be destroyed, or he had but one.

On the other hand, if the second kidney is sound, and the fistula badly tolerated by the patient, nephrectomy is the final resource.

In my own case a permanent lumbar fistula followed, and continued (with intermissions) over a period of seven years. At the end of two years an attempt was made to perform nephrectomy, but the kidney could not be found, and yet for five years afterwards urine continued to flow from the fistula, but in diminishing quantity, till it finally closed. Subsequently, after a period of three years, a persistent purulent fistula following an abscess in the loin developed, and a further attempt to remove the kidney and ureter was made. Ureterectomy was effected, but the kidney was found to be represented by only a mass of fibrous tissue.

Of course, after lumbar incision, it would be requisite to use all customary precautions against sepsis; and if this is done successfully, and the lumbar incision has been made soon after the first development of the swelling, there is but little, if any, reason why the kidney should become the seat of suppurative changes more than after nephro-lithotomy, or partial excision of the kidney for tubercle or abscess. In my own case twenty-four to thirty ounces of urine—and just about the same amount as was passed *per urethram*—escaped daily by the lumbar fistula until the patient neglected the drainage and allowed the external aperture to close, which he did some eleven months after the accident. Subsequently, when the fistula had to be re-opened, pus as well as urine was discharged through it. Ultimately only pus came from the lumbar fistula. It was, however, found that the kidney suppurated in all three of the cases in which the retro-peritoneal collection was drained; but in one of them (Godlee's) there was pus in the fluid withdrawn when the cyst was first punctured, and before it was laid open by lumbar incision. In another (Chaput's) there were special conditions favouring sepsis, because there was a communication between the large bowel and the retro-peritoneal collection of urine; and in the third case the drainage was imperfect, being made through the linea semilunaris, instead of through the ilio-costal space behind.

Nephrectomy.—Nephrectomy will be required if pus in the extravasated fluid, continued high temperature or recurring pyrexial attacks with pain, loss of appetite, and emaciation, make it clear that the kidney or the retro-peritoneal tissue is the seat of extensive and persistent suppuration. Nephrectomy may be demanded also in the absence of suppuration if a permanent fistula has resulted and is a source of intolerable discomfort.

It has sometimes been stated that primary nephrectomy would be the best treatment in all cases of subcutaneous injury, whether of the kidney, renal pelvis, or ureter, attended with retro-peritoneal extravasation of urine; but I am not of this opinion. Undoubtedly the danger of primary nephrectomy for severe injury is not inconsiderable; and, on the other hand, the chances of recovery after secondary nephrectomy for septic nephritis are less than after primary nephrectomy for injury. Still, the chance of recovery with perfect function of the kidney on the injured side ought to be given to the patient; and this will be done by a prompt incision through the loin, as soon as a retro-peritoneal swelling is formed, followed by free drainage into antiseptic dressings: or by performing a suitable plastic operation on the ureter when this is possible. Should this not succeed, secondary nephrectomy will very probably save the life of the patient; it did so in the three cases referred to above, and has done so in several similar cases, where the substance of the kidney or the renal pelvis has been torn.

In traumatic hydro-nephrosis a trial of ureterotomy for division of the stricture should be made, as was so successfully carried out in Fenger's case.

ABSTRACTS OF THE TWELVE CASES REGARDED AS SUBCUTANEOUS URETERAL INJURIES.

Group A.—CASE 1.—Poland's case* was that of a woman, aged thirty-three, in the fifth month of pregnancy, who was squeezed and slowly twisted half a revolution between the platform and the footboard of a railway carriage. On admission there was a small superficial wound of the abdominal wall, about one inch and a half to the left and a little above the umbilicus, with a subcutaneous laceration of the peritoneum and the sheath of the rectus muscle, through which, on the fourth day, sixteen inches of intestine bulged. On the fifth day she aborted, and on the sixth died of asthenia.

A few drops of urine were passed on the afternoon of the fourth day, but as this was with the motion, and was thrown away by the nurse, it was not ascertained whether blood was mixed with it or not.

A post-mortem examination revealed fracture of the spinous processes of all the lumbar vertebræ, both twelfth ribs, and both transverse processes of the upper three lumbar vertebræ. The right lumbar region was raised into a great dark swelling by blood effusion. The right ureter was torn quite across, just below the pelvis of the kidney, so that it terminated in a ragged end in the midst of the half-sloughy, putrescent, jelly-like tissues which surrounded the organ. The capsule of the right kidney was separated from the parenchyma by a considerable quantity of blood-clot, extravasated over the anterior aspect of the organ, and prevented the mixing of this blood with the urine extravasated from the ruptured ureter. The blood under the capsule was derived from a rent in the posterior and lower part of the organ, which penetrated to and opened a vein at the base of one of the pyramids. The left kidney was in a very remarkable condition; it had a buff-pink or yellow-clay colour, very opaque and dead looking. On section, the whole of the vessels were blocked up with ante-mortem clot, which extended in both artery and vein to the principal vessel. In the trunk vein the clot was non-adherent; in the artery it was firmly adherent, but there was no wound of the arterial coats.

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* *Guy's Hospital Rep.*, London, 1868, 3rd series, vol. xiv., p. 86.

With such extensive damage to the kidney tissue it is impossible to draw any accurate conclusions from this case as to the symptoms due to rupture of the ureter.

The suppression of urine was evidently due to compression of one gland by subcapsular hæmorrhage, and thrombosis of all the vessels of the other. The case, besides other points of interest, affords an illustration of subcapsular extravasation of blood in the kidney, a form of injury to which attention has not yet been specially drawn, but of which I have seen three or four marked instances.

Case 2.—Coull Mackenzie's case is the only example of extravasation of urine into the peritoneal cavity due to a subcutaneous injury of the ureter.*

It is that of a coolie who was jammed between two heavy trucks. There was no external mark of injury. There were two small ruptures, each the size of a pea, in the right ureter. The abdominal cavity contained two pints of urine mixed with blood. The patient died from peritonitis, following the extravasation through the ruptures of the ureter. This case affords no special symptoms beyond such as are caused by fatal perforative peritonitis.

Case 3.—My own case was that of a strongly built man, aged thirty years, who fell from his van, one of the wheels of which caught him a blow in the right loin. This occurred on September 30th, 1887. One of his ribs was fractured, and he passed a little blood from his bowel for a few days, but had no hæmaturia at any time. This was closely watched for, and his side and abdomen were carefully and repeatedly examined during a stay of nearly three weeks in St. Thomas's Hospital, whither he was taken immediately after the injury. Morphia was required during some days to relieve abdominal pain. On 26th October, about a week after leaving St. Thomas's Hospital, a painful swelling formed in the right loin, and very rapidly increased during the following twenty-four hours. On October 27th he was admitted into the Middlesex Hospital under my care, and a lumbar incision was at once made, and over one hundred ounces of urine, slightly blood-stained, were removed. A large rent was felt in the renal pelvis, but it was not ascertained at that time that the ureter was torn away from the infundibulum, as subsequent events show it must have been. The kidney had been carried forward with the peritoneum, and formed part of the anterior wall of the lumbar swelling. Permanent drainage was kept up, and from twenty-four to thirty ounces of urine were daily passed through the loin incision; a similar quantity was passed through the bladder.

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* "Med.-Legal Experiences in Calcutta," Edinburgh, p. 98.

In September, 1888, the man returned to the hospital with a large swelling in the right loin, which had formed since he discontinued the drainage and the fistula had thus been allowed to close. The swelling was evacuated, more pus than urine escaped from it, and the drain tube was re-introduced. The same neglect of drainage was followed by the same sequence of events, and in June, 1889, an ineffectual attempt was made to perform nephrectomy, but the kidney could not be distinguished in the tough, dense cellular tissue of the loin.

A drainage tube, attached to a portable urinal, was again introduced, and the patient was urged to continue to wear it. This he did—following his occupation and in perfect health the while—till the fistula finally closed in July, 1894. The amount of urine discharged through the fistula had for a long time previously been gradually diminishing, and led me to the conclusion that the kidney as a secreting organ was gradually being destroyed. He remained well till October, 1897, when a fresh abscess formed, and was opened through the old scar. This did not quite heal, but swelled and became inflamed from time to time. For this reason, he requested me to make another attempt to remove the kidney. On November 15th, 1897 (ten years and six weeks after the original injury), a long curvilinear incision, as for nephro-ureterectomy, was made, and a most careful search instituted for the kidney. Only a flattened fig-shaped mass of fibrous tissue occupying the place of the kidney could be found. The ureter was next sought for where it crosses the iliac vessels, and was found and

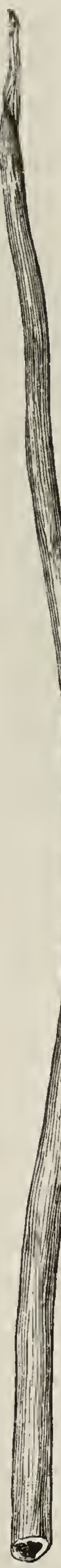

Fig. 154.—Ureter removed during life, ten years after rupture. Author's Case. (Middlesex Hospital Museum.)

traced upwards towards this fibrous mass. Whilst a little traction was being made upon the ureter, it tore away from its upper connections below this fibrous mass. It was a very slender tube, quite closed at its upper end, where it has the appearance faithfully shown in the accompanying figure (Fig. 154). The man made an excellent recovery, and is still well and at hard work.

Group B.—Four cases (Stanley's, Godlee's, Chaput's, and Page's), in each of which there was a retro-peritoneal collection of urine, were possibly instances of rupture of the ureter.

Case 4.—Stanley,* in a paper on rupture of the ureter, records the case of a boy, aged nine, who was squeezed between the wheel of a cart and the curb-stone. The immediate consequences were contusion of the soft parts around the pelvis, and great pain in the lower part of the abdomen, much ecchymosis and extensive suppuration in the subcutaneous cellular tissue around the pelvis, from which several ounces of matter were discharged by puncture near the left sacro-iliac synchondrosis. By the end of the sixth week these soft parts had recovered, but a large circumscribed oblong swelling was found in the right side of the abdomen. The urine was passed naturally throughout.

From this swelling fluid having some of the characters of urine was withdrawn by puncture with a small trocar and cannula. The swelling recurred again and again.

It was punctured altogether six times in a period of five months and a half. It refilled again, and extended from the linea alba to the right lumbar region, but further evacuation was considered inexpedient, and the boy was discharged from the hospital nine months after the accident. Subsequently he was often seen in good health, but with the abdominal swelling distinct.

Thus in this case of Stanley's, which, ever since Poland referred to it in 1868, has been quoted over and over again as one of ruptured ureter, we have no proof whatever of the exact part injured, nor of the ultimate result of the injury. It is more likely to have been a ruptured renal pelvis than a ruptured ureter.

Stanley states that by his exploratory puncture he learnt that the fluid was situated immediately beneath the abdominal muscles, and had formed for itself a cavity, by detaching the peritoneum from the abdominal and lumbar muscles. As to the source of the effused urine, he quotes the opinion of Mr. Taylor, who analysed the fluid, " that, owing to the absence of mucus in it, the probable source was as high up in the urinary apparatus as at the commencement of the ureter." This means only that Mr. Taylor did not think the urine he examined had come from the bladder.

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* *Med.-Chir. Trans. Lond.*, 1844 vol. xxvii.

The other case in the paper referred to is specifically stated by Stanley as being one of ruptured pelvis of the right kidney, the nature of the injury having been ascertained by post-mortem examination.

Case 5.—R. J. Godlee,* in an interesting communication in May 1887, on " Three Cases of Abdominal Cysts following Injury," recorded the case of a little girl, aged four, who had been run over by a cab. Pain, tenderness, and burning in the left inguinal and lumbar regions resulted. Nothing further was revealed until a fortnight had elapsed, when an indefinite swelling in these parts was detected. Within three weeks from the date of injury, this had developed into a large, well-defined, fluctuating tumour, which extended from the iliac spine to the level of the eighth rib, and reached to within half an inch of the median line in front. No change had been observed in the urine. By the aspirator a large quantity of turbid alkaline urine was withdrawn, containing 3 per cent. of urea, much albumen and mucus, a small quantity of pus, and some phosphate crystals. The cyst refilled within two days, to the same size as before. At the end of one month from the date of the injury an incision was made in the ilio-costal space, and a drain tube inserted. Then followed a copious and persistent leakage of urine from the wound and a series of pyrexial attacks, so that, at the end of three months and a week after the original injury, lumbar nephrectomy was performed.

Mr. Godlee had great difficulty in finding the kidney, which was situated at the upper and anterior part of the sac, pushed forward with the peritoneum; and great difficulty in removing it, as it was embedded in dense fibrous tissue. The child recovered, but with a fistula.

It was assumed before the nephrectomy was undertaken that the ureter was completely ruptured, " because no blood had appeared at any time in the urine, and if the laceration had been in the kidney it would probably by this time have closed." The history of cases of injury to the kidney shows, however, that these reasons are not sufficient for this conclusion. The absence of blood in the urine, and the persistence of the escape of urine from the wound prior to the nephrectomy, are symptoms which have often been met with in cases of ruptured renal pelvis.

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* *Trans. Clin. Soc. Lond.*, vol. xx., p. 219.

No description is given of the kidney removed, and one is led to infer that it was taken away piecemeal, and that it was impossible to tell whether the renal pelvis and the renal substance had been injured in the first place or not. There is difficulty in accepting the fistula in this case as evidence that the ureter was torn across; it seems improbable that a detached portion of the tube would cause more trouble than the open end of the ureter, or even a large part of the expanded renal pelvis, which in many cases has been left behind to form part of the stump of the pedicle.

CASE 6.—M. Chaput* reported the case of a lad, aged sixteen, who is described as having had his right ureter and the back of the cæcum ruptured by a kick from a horse's hock in the right flank. The case was one of great difficulty of diagnosis, and the operative treatment was complicated by opening the peritoneum and the front wall of the cæcum. The surgical wound in the front of the cæcum, as well as the traumatic rupture (from 1 to 2 cms. long) in the back of the cæcum, were sutured, and a large perinephric extravasation was incised and drained through the loin, but subsequently the kidney was removed, because of the persistence of the fistula and the general state of the patient. An examination of the kidney after removal showed it to be in a state of general ascending suppurative pyelo-nephritis. Its lower extremity was very friable and bathed in a collection of pus. The renal pelvis was quite intact, and absolutely without sign of rupture, as was also the ureter for a distance of from 1 to 2 cms., but the actual seat and nature of the rupture below this point was not ascertained.

It is a question whether the friable, pus-bathed condition of the lower end of the kidney was due to injury which had ruptured the calyces and allowed escape of urine into the surrounding tissues, or whether it was due to changes subsequent to rupture of the ureter.

CASE 7.—Herbert W. Page† reported the case of a boy.

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* *Bull. et Mém. Soc. de Chir. de Paris*, 13 Mars, 1889.

† *Ann. Surg.*, St. Louis, May, 1894.

aged five, who was knocked down on September 24th, 1892, by a light vehicle, the wheel of which was said to have passed over the abdomen.

There was no immediate evidence of injury, but within two days blood was noticed occasionally in the urine.

The temperature rose to 100° and 102° on two days, and then returned to normal. Twenty days after the injury the temperature rose again to 100° and 103°, and a swelling formed in the right iliac fossa, accompanied by abdominal tenderness and impaired respiratory movements.

On October 27th the abdomen was opened along the right linea semilunaris, and some clear serous fluid escaped from the peritoneal cavity.

Forty ounces of fluid, having some of the characters of urine, were removed from the swelling behind the peritoneum, the edges of the cyst wall were attached to the anterior parietal peritoneum, and the space was drained.

The kidney and upper two inches of the ureter were exposed to view, and found to be uninjured and healthy. The ureter below this part was not visible, and it was concluded that the urine had escaped through a rupture in it lower down.

In November nephrectomy was performed, because of the continued escape of purulent urine from the retro-peritoneal cavity, and the high fever. The kidney was then found to be three times its normal size, and in a state of ascending suppurative nephritis; the renal pelvis was distended with purulent urine, and this, as well as the upper part of the ureter, was entire. The bladder had previously been proved by injection to be intact. The child ultimately recovered completely. The actual lesion of the ureter, however, was never seen, and some doubt may reasonably be felt about its precise nature.

Group C.—The five cases on record in which abscess-like dilatation of the calyces of the kidney, polycystic disease, or hydro-nephrosis has been attributed to injury of the ureter, are the following:—

In three of them (Haviland's, Pye-Smith's, and Soller's) it was proved post-mortem that the ureter of the affected kidney was at some point contracted or obliterated, and the history in each case suggests that this might have been caused by an injury to the loin, received at periods of four, two, and nine years respectively before death.

In the fourth case (Cabot's) recovery without a fistula ensued after nephrotomy and drainage. The exact nature of the injury in this case was not ascertained, and it is therefore not possible to say that it was the ureter and not the renal pelvis that was damaged.

The fifth case (Fenger's) was one of subcutaneous injury followed by stricture of the ureter, and resulting in intermittent hydro-nephrosis. It was cured by ureterotomy, with closure of the divided wall of the strictured portion after the Heinecke-Mikulicz method.

CASE 8.—In Haviland's case* a lad, aged eighteen, sustained a fall on his back from a height of twenty feet four years before his death. For several years he had been subject to a painful incontinence of urine and great pain in the loins and urinary passages, the urine throughout being charged with pus and sometimes with blood. After death the right kidney was found to have lost all its original structure, and to be converted into a series of sacs, containing pus-like fluid, each cavity being lined with a distinct membrane, which, when separated, preserved its shape. The cavities appeared to have no outlet, and the ureter was atrophied and impervious.

Some doubt must be felt as to this condition being the result of injury rather than of tuberculous disease, especially when we consider the history and the changes in other parts of the urinary organs. Thus the right kidney contained a similar cavity, and the corresponding ureter was considerably enlarged and embedded in fat, in which were a great number of indurated lymphatic glands; the bladder was contracted and its mucous membrane covered with pus, the urethra being in a similar condition.

The parents attributed the boy's illness to his fondness for bathing, affirming that up to his thirteenth year he was perfectly healthy.

The fall seems to have occurred about a year later than this, when the lad was fourteen, and he only received a shaking, from which he soon recovered.

CASE 9.—In Pye-Smith's case † a young farrier, aged twenty-four, had been frequently kicked in the abdomen, and on one occasion, about two years before his death, hæmaturia of several days' duration occurred after a kick from a horse on the left side, "under the short ribs." He was only in bed three days; and after recovering, till his last illness, felt no inconvenience and had no return of blood in the urine.

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* *Trans. Path. Soc. Lond.*, 1859, vol. x., p. 209.

† *Ibid.*, 1872 vol. xxiii., p. 159.

The final illness was ushered in with diarrhœa and an abdominal tumour, attended with pain and vomiting. The tumour was tapped more than once, and several pints of opaque reddish fluid containing pus and blood cells were drawn off. Diarrhœa recurred, and ended in the patient's death. On post-mortem examination the kidney was found dilated into a series of sacculi, communicating with each other and with the renal pelvis, and contained a yellow puriform fluid, like that which had been removed during life. A communication had been established between the interior of the kidney and the adherent descending colon, which explained the diarrhœa and the presence of intestinal matter in one of the renal pouches. The ureter was dilated for one inch and a half, when it suddenly became contracted, so as not to admit the smallest probe. A few lines further on it again assumed its normal size. Pye-Smith seems to have taken pains to exclude calculus, tubercle, and other possible causes of the ureteral contraction.

CASE 10.—M. J. Soller,* Interne des Hôpitaux de Lyon, reported the case of a joiner, aged forty-five, who nine years before, during the campaign of 1870, received in the left hypochondrium, below the last rib, a blow from the bursting of a shell, which did not penetrate or even involve the skin. After the injury he felt continually a violent pain on the left side, at the level of the part struck, which was augmented by cold or changes of temperature. A year and a half afterwards his left testicle suppurated, but recovered. The pain in the left hypochondrium led to difficulty in respiration, amounting almost to suffocation, and was accompanied by violent beating of the heart. These symptoms increased up to 1879, when the signs of nephritis developed, and were followed by ascites, anasarca, anæmia, convulsions, and death in August, 1880.

At the post-mortem the left kidney was enlarged one-third, and consisted of a congeries of cysts of varying sizes and contents, separated by partitions of fibrous tissue. All the renal tissue had disappeared. There was considerable hydro-nephrosis, and the renal pelvis was filled with sero-purulent fluid. The ureter was the size of a quill pen, with thickened walls, and in the middle of its course it was so contracted as scarcely to admit the head of a pin. At the level of the contraction of the ureter the cellular tissue surrounding was indurated and chronically inflamed. The right kidney was very much congested.

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* *Lyon Méd.*, 1880 t. xxxv. p. 333.

This, I should say, was not a case of rupture but of contusion of the ureter. Had there been rupture there would surely have been extravasation. If the conglomerate cystic condition was (and in all probability it was) developed after the accident, it supports the theory of the cysts being due to obstruction, not to an adenomatous change.

Case 11.—Dr. A. T. Cabot* reported the case of a boy, aged ten years, who for three or four days after falling down-stairs passed bloody urine, and several weeks later developed a swelling which increased into a prominent fluctuating tumour, filling the right side of the abdomen.

It was twice aspirated, and large quantities of a clear, slightly yellow fluid, having the characters of altered urine, were withdrawn. The fluid was alkaline, had a specific gravity of 1007, and contained one-fourth of albumen, red and white blood corpuscles, and large round cells in varying numbers. Urea in small amount was discovered at the second tapping. As the fluid reaccumulated, a vertical incision was made in the ilio-costal space, and the cyst wall was incised and stitched to the skin. "The finger passed into the cavity felt a soft nodular mass, probably the kidney, in the posterior part of the cyst. The ureter could not be felt." Between two and three pints of amber-coloured fluid escaped, having similar characters to that previously withdrawn, but in addition indican, chlorine, uric acid, and triple phosphate crystals, and round cells like renal epithelium, were noted.

The boy recovered without fistula, five and a half weeks after the operation. This case was reported by Cabot as one of "nephrotomy for hydro-nephrosis," and the treatment described of the cyst wall, the character of the fluid, and the position on the posterior instead of on the anterior wall of the cyst, of what he took to be the kidney, support this view. There is nothing in the description which is proof of the injury having been a ruptured ureter. The case was doubtless one of traumatic hydro-nephrosis from blood plugging the ureter.

Case 12.—Fenger's case was published in the *Chicago Medical*

* *Boston Med. and Surg. Journ.* Feb. 22nd, 1883.

Recorder for March, 1893. It is described by Fenger himself as one of "traumatic stricture of the ureter close to its entrance into the pelvis of the kidney," causing intermittent hydro-nephrosis. The patient, who was forty-seven years of age, had sustained an injury thirty-four years previously. Hydro-nephrosis developed ten years afterwards. Lumbar nephrotomy disclosed no calculus. The ureteral orifice could not be discovered through the renal incision; the dilated pelvis was then explored, but still the orifice of the ureter could not be found. The ureter was then isolated, and its upper end found to be embedded in cicatricial tissue for half an inch. Lower down, though small in calibre, the duct was normal.

A longitudinal incision, 1 cm. long, was made in the ureter just below the cicatrix. The stricture itself was 1 cm. in length, and was incised upwards into the renal pelvis. The ureteral wound was then stitched longitudinally, according to the Heinecke-Mikulicz procedure in the treatment of pyloric stricture. No bougie was left in the ureter. A drainage tube was passed into the pelvis through the wound in the kidney. The patient made a good recovery without return of the hydro-nephrosis. This operation was performed on November 26th, 1892.

CASE 13.—During the year 1900 a specimen was added to the Museum of the Royal College of Surgeons (Appendix Museum Catalogue, A 3519), showing the kidney and the ureter of a child, removed during life by Mr. E. C. Stabb. In addition to laceration of the upper part of the kidney, the ureter has been almost completely torn across just below the pelvis. The injury was caused by a horse trampling on the abdomen. The patient was seen twelve hours after the accident, when primary nephrectomy was performed. Death from shock followed. The case is as yet unpublished.

Group D.—Cases usually quoted as rupture of the ureter, but which are really cases of rupture of the renal pelvis, or renal substance opening calyces:—

Allingham, H.—*Brit. Med. Journ.*, London, 1891, vol. i., p. 699. Bardenheuer. —"Drainerung der Peritonealhohle," 1881, s. 1733. Barker.—*Lancet*, London, January 17th, 1885. Bennett May.—*Brit. Med. Journ.*, London, 1883, vol. i., p. 669. Croft.—*Trans. Clin. Soc. Lond.*, 1881, vol. xiv. ("Traumatic Hydro-nephrosis"). Dumenil, M., quoted by Le Dentu, "Affections chirurgicales," 1889. Harrison.—"Surgical Diseases," p. 328; "Lectures on Surgical Disorders of the Urinary Organs," 1880. Hicks. —*Med. Rec.*, New York, April 17th, 1880 ("Traumatic Hydro-nephrosis").

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CHAPTER V.

INJURIES OF THE URETER (*Continued*).

CLASS II.

PENETRATING WOUNDS OF THE URETER.

Penetrating wounds of the ureter are altogether exceptional. This is true both of wounds produced by firearms and of wounds caused by sharp- or blunt-pointed weapons. There are, so far as I am aware, only two instances of wounds by firearms and three of wounds by penetrating weapons recorded. None of either kind occurred in the American War of the Rebellion; Otis thinks this is probably because such wounds would be likely to concern also the trunk vessels, and therefore not to come under treatment in hospital; and though several cases of uncomplicated penetrating wounds of the *kidney* appear in the German War reports,* not one of wound of the ureter is mentioned.

In each of the cases of penetrating wound, as of subcutaneous wound of the ureter, verified as such by post-mortem examination or observation on the operating table, the injury of the ureter has invariably been near the pelvis of the kidney. Hence the diagnosis, symptoms, and treatment of these injuries, so far as our knowledge up to the present time extends, in no way differ from those of wounds of a similar nature affecting the pelvis of the kidney. The scanty facts at our command as to gun-shot wounds are supplied by the case related by Hennen in 1815 of the soldier Labiche, and that of the Archbishop of Paris in 1848; and as to punctured wounds, by the cases reported by Le Fort, Demons, and Nepveu, in which the vulnerating weapons were a shoemaker's knife, a knife, and a stiletto respectively.

The following are the notes of the case of the Archbishop, abstracted from the report in the *Gazette des Hôpitaux*, 1848. During the Revolution of 1848 (June 29th), the Archbishop of Paris was wounded by a ball at the upper part of the lumbar region on the right side of and close to the spine. The ball was lodged in the body. He had intense suffering, great depression, and paralysis of the limb, but no anæsthesia with it. After recovering from slight collapse, reaction set in, accompanied by continued and acute pain, more especially in the left leg, and down the course of the sciatic nerve. Nausea and vomiting supervened, the countenance became pale and anxious, the abdomen was flaccid, and not at all painful. The wound was enlarged, and unsuccessful attempts were made to extract the ball. There was no urine in the bladder, but a quantity escaped by the wound. Death ensued in eighteen hours. On examination, the ball was found to have fractured the transverse process of the third lumbar vertebra, to have then changed its direction and traversed the body of the same vertebra, and to have divided the cauda equina just below its origin. After leaving the vertebra, the ball changed its direction again, and passing up toward the left kidney, divided the ureter near the pelvis, and finally lodged in the psoas muscle. All the cellulo-fatty tissue about the left kidney was infiltrated with urine, and there was slight ecchymosis in the substance of the organ itself.

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* Ernst Grawitz, *Arch. f. klin. Chir.*, Berlin, 1889, xxxviii., 419–433.

Hennen in his "Military Surgery"* records a case which is doubtfully one of gun-shot wound of the *ureter*. Though he does not himself quote it as such, it has been referred to by several recent writers, but I think wrongly so, as being one of these very rare cases.

Hennen's case is given in full by Rayer as a case of recovery from gun-shot wound of *the kidney*.† Hennen relates it merely as a case of "passage of air by the urethra" after venturing the conjecture that air is sometimes, but very rarely, passed from the bladder, most probably from some *opening in the ureter* communicating with an external wound; or, as in the cases mentioned by Camper,‡ from ulcerations connected with the intestines. The patient, A. Labiche, of the 7th French dragoons, was wounded on June 18th, 1815, by a musket ball, which entered the left hypochondrium, directly under the twelfth rib, near its anterior extremity, and came out to the left of the second vertebra of the loins, close to the spinous process. Some blood passed through the urinary passage the first few days after the infliction of the wound. Up to July 13th the discharge through the wound in the back was very free, and was mixed with thin fæces and the seeds of fruits which he had eaten. On the 14th air passed through the urethra. On the 20th urine passed from the wound in the back. The passage of air bubbles from the urethra, and of urine from the wound in the back, ceased entirely about August 8th, which was fifty-one days after the injury; but six days later air again passed by the urethra and a urethral discharge appeared. The man soon after began to improve fast; and it was believed by his medical officer that he finally quite recovered.

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* Third ed., p. 430; case lxxii.

† "Traité des Maladies des Reins," vol. i., p. 268, case ix.

‡ "Demonstrat. Anatom. Patholog.," lib. ii., p. 16. *See* also a case by Dr. Fothergill, Duncan's "Medical Commentaries," vol. ii., p. 194.

The most probable explanation of this case seems to me to be this: The initial injury was inflicted upon the parietes and the descending colon, with in all probability some contusion of the *pelvis of the kidney;* but during the progress of the suppuration which followed there came to be a temporary communication between the colon and the renal pelvis. The line taken by the bullet was from a point immediately below the anterior extremity of the left twelfth rib to a point close to the spinous process of the second lumbar vertebra on the left of the median line. This is on a level with the pelvis of the kidney, and above the point of commencement of the narrow tube of the ureter. That the renal pelvis was contused by the bullet is indicated by the hæmaturia of the first few days after the injury; when this contused part of the kidney sloughed away, air could pass from the colon or from the external wound, and urine from the loin, as happened on the twenty-sixth and thirty-second days, and subsequently. The colon must have been injured at the outset, because thin fæces escaped from the wound in the back soon after its infliction.

Mr. Holmes* recorded a case of great interest, which at first he considered to be a direct and uncomplicated wound of the ureter through the posterior parietes of the abdomen.

A boy, aged thirteen years, was stabbed by a clasp-knife, which entered the back just on the right of the middle line, and about on the level of the posterior superior spine of the ilium. The wound took a direction upwards and outwards, and through it there flowed for two weeks a quantity of a colourless, odourless, neutral or slightly alkaline fluid, of sp. gr. 1008. After this time the flow ceased altogether. The author concluded that this fluid must have been either urine from a punctured ureter, or cerebro-spinal fluid, and he strongly inclined to the view that it was not cerebro-spinal fluid. It is quite certain, however, from the composition of the fluid, that it was not ordinary urine, and was much more nearly like cerebro-spinal fluid; and as Mr. Holmes has, in a subsequent communication,* come to the conclusion that this case was really one of wound of the theca vertebralis, and not of the ureter, I need do no more than say that he has at least shown, by experiment on the dead subject, that it is possible to wound either the ureter or the theca vertebralis by a stab in the back, at the position of the wound in this boy.

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* *Roy. Med.-Chir. Soc. Trans.,* vol. lx.

M. Léon Le Fort has published† a case of special interest because it was the first instance of nephrectomy on the living subject in France.

The patient was a man aged twenty-three, who on September 24th, 1879, in a suicidal act thrust a shoemaker's knife into his loin and completely divided his right ureter. The superficial wound was transverse and only 15 millimetres in length, and was situated just below the false ribs, 4 centimetres (about 1¾ inches) to the right of the median line. During the first few days the symptoms were those of partial peritonitis of the right side of the abdomen. Twenty days after the infliction of the wound a fluctuating swelling was opened above the fold of the groin, and a litre and a half of yellow liquid-like ascitic fluid, followed by a considerable quantity of creamy pus, at once escaped. A finger introduced into the wound came in contact with the surface of the ilium, but could not detect the iliacus muscle. A counter-opening was made in the loin at the same time. Pus and urine were discharged through a drainage tube in the lumbar wound, and there was more or less elevation of temperature for three months. The amount of urine discharged by the wound during the month of November was greater than that which was passed by the urethra: that coming through the wound was alkaline and contained crystals of ammonio-magnesian-phosphate, while that passed by the urethra was acid and contained crystals of uric acid and urate of ammonia. By December 31st the general condition of the patient had greatly improved and the flow of urine by the lumbar fistula, which for five days had been gradually diminishing, ceased altogether and the fistula closed. During January, however, both fistulæ reopened and gave exit to urine—first the cicatrix of the inguinal fistula gave way, and some days later that of the lumbar wound. Then fever returned, again pus was mixed with the urine, vomiting and diarrhœa set in, and the patient was rapidly losing strength. Under these circumstances Le Fort determined to follow the example set by Simon and to remove the kidney. (Simon's case was of a very different nature, however, being one of urinary fistula following a wound of the ureter inflicted during an ovariotomy, in which he tried unsuccessfully to unite the divided ends of the ureter.)

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* *Roy. Med.-Chir. Soc. Trans.*, vol. lxv.

† *Bull. de l'Académie de Médecine*, Nov. 9, 1880, p. 1185.

Le Fort operated on May 20th, 1880, and the details he gives of the difficulties experienced are very instructive, being identical with what other surgeons have since encountered when performing or attempting to perform nephrectomy, or other operation on the kidney, in cases where a lumbar urinary fistula and perinephric suppuration have long existed. He found all the tissues thickened and indurated by inflammation to such an extent that the sides of the wound would not yield sufficiently to enable him to displace them with his fingers in order to reach the kidney. He describes the trouble it was to separate the thickened and toughened renal capsule from the surrounding fibro-fatty cellular tissues, and the impossibility of detaching the upper end of the kidney without tearing the contiguous substance of the liver away with it. He also relates how, to enable him to remove the kidney, he was obliged to excise part of the last rib, and to detach the kidney from its own proper capsule, which was more than a centimetre thick and which he left behind in the wound.

He tells too how the diagnosis he had formed—namely, that the ureter had been cut, and the retro-peritoneal abscess had been caused by urine extravasated through the divided tube—was shaken when the fistulæ ceased to give exit to urine and remained healed for a fortnight. He then thought he ought to make sure that he had not to do with a perforation of the bladder, the result of the retro-peritoneal abscess which had followed the injury, and he relates how he then tested the bladder to see if the urine had escaped from it and not from the ureter, with the result that he could not doubt that the ureter near the renal pelvis was the seat of injury. The method he adopted was the injection of the bladder with a solution of iodide of potassium, and the application of a bandage and pad soaked in a solution of nitrate of lead over the fistula. No colour change was effected on the lead solution. The patient died from vomiting and partial suppression of urine on the second day after the operation, and at the post-mortem examination the division of the ureter near the renal pelvis was verified. The part of the ureter above the injury was very short and opened into the abscess cavity, which partly surrounded the kidney. The ureter below was not obliterated, and extended downwards along the internal wall of the retro-peritoneal abscess cavity, its upper end opening by the side of the cut extremity of the superior portion.

The case reported by Le Nepveu* is remarkable. The patient was a maker of fishing tackle, aged thirty-four. The wound was inflicted by a gouge or gimlet for boring the pieces of cane used for fishing rods, upon which he accidentally sat, and which entered at the right femoro-perineal fold and, passing obliquely upwards for a distance of 12 cm. across the floor of the pelvis, reached the left ureter and cut it clean across, at a point 5 cm. above and behind the bladder. The man was at once seen by M. Verneuil; almost complete suppression of urine followed and continued till his death on the fifth day.

Demons' case is mentioned by Le Dentu and by Tuffier as having been reported by Biar in his "Thèse" on "Les Fistules de l'Urétère," (Bordeaux, 1884); but no particulars are given by them beyond the statement by Le Dentu that the wound was inflicted with a knife. I have failed in my endeavours to gain access to this thesis.

With so few facts before us it is impossible to formulate any precise description of the diagnosis and the symptoms which are to be expected in penetrating wounds of the ureter.

As to **prognosis**, the result to be looked for is either death or a permanent fistula. The injury to the ureter may be associated with fatal injury to some other parts or organs, as in the case of the Archbishop of Paris, and in Verneuil's case, recorded by Nepveu and Cerou, in which the peritoneum, the common iliac vein, the prostate, and the seminal vesicles were wounded. If the peritoneum is penetrated death sooner or later is likely to follow from peritonitis. If the damage is confined to the ureter a permanent fistula must result, except in the very improbable event of the injury to the ureter being a puncture or oblique division, or an incised longitudinal wound, any of which might soon close, especially the last, as such wounds do after simple ureterotomy and nephro-ureterotomy. Wounds in which the edges are much contused will slough and will not close. A large oblique or transverse division of the ureter, whether complete or not, will not heal, and a permanent fistula will follow unless or until the kidney is destroyed. If such a wound is not from the first septic, urine alone will be discharged through it, but should suppuration arise either from neglect of drainage or want of cleanliness, the proximal end of the ureter is likely to become blocked, or uretero-pyelo-nephritis will arise and the kidney will in time atrophy and be converted into fibrous tissue, or become the source of danger or a cause of death from septic absorption and fever.

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* *Gaz. Hebdom. de Méd. et de Chir.*, Février 16, 1877. *See* also case 2 in Étienne-Marius Cerou's thesis, "l'Oligurie et l'Anurie Traumatiques," Paris, 1877.

Treatment.—The proper course to pursue if the peritoneum is wounded is immediately to carefully cleanse the cavity, and if possible to suture the ureter or else the peritoneal covering of the ureter through an anterior abdominal incision, and then to drain by a lumbar incision. When the peritoneum is not injured, a free lumbar incision should be made and the wound in the ureter looked for and if possible closed by one of the methods described in the chapter on Ureteral Anastomosis, *post*, p. 531. If the original wound is in the ilio-costal space this may be enlarged, if elsewhere a fresh incision should be made as for nephrotomy and nephro-ureterotomy. Drainage should afterwards be employed until the wound in the ureter is healed.

CHAPTER VI.

INJURIES OF THE URETER (*Continued*).

CLASS III.

ACCIDENTAL WOUNDS OF THE URETER OCCURRING DURING ABDOMINAL AND PELVIC OPERATIONS, OR DURING PARTURITION.

THE third class of wounds of the ureter include those which are made accidentally or intentionally by the surgeon; those which are caused directly or indirectly by the use of obstetric instruments, and those which result from gangrene due to pressure in a prolonged or difficult labour.

Wounds are made *intentionally* by the surgeon (1) for the removal of impacted calculi; (2) for correcting obstruction caused by valve-like folds of the ureter; (3) for excising a stricture; (4) for transplanting the upper end of a ureter into the dilated renal pelvis of a hydro-nephrotic kidney, or the lower end into the bladder or into a vesical pouch, as Dr. Abbe * has done, or into the bowel or on to the surface of the body; (5) for establishing a ureteral fistula, either for the purpose of ascertaining the condition of the kidney on the opposite side,† or of providing for the excretion of urine when the ureter is irremediably stenosed or compressed. These wounds fall to be considered under Operations on the Ureter.

Wounds caused during vaginal hysterectomy and other pelvic operations and not recognised at the time, and those which result from sloughing of the vagina or os uteri, implicating the neighbouring part of the ureter, give rise to *uretero-vaginal* or *uretero-uterine fistulæ,* and will be considered under that heading.

Transverse and oblique wounds of the ureter accidentally inflicted by the surgeon.—The most frequent of all wounds of the ureter are those inflicted during such operations as hysterectomy, especially vaginal hysterectomy; ovariotomy; the removal of suppurating tubes; and other abdominal operations such as are now performed daily. The ureter has also been wounded in the performance of Kraske's* operation, undertaken for the removal of what was considered to be a thick-walled abscess between the rectum and the bladder (Abbe).

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* *Annals of Surgery,* vol. xx., p. 1837, 1894.

† *See* Agnew, *Phila. Med. Times* for 1881.

Reichel† of Würtzburg met with an exceptional case of unintentional wound of a cystic dilatation of the ureter during an operation for right-sided inguinal hernia in a boy nine and a half years old. A large cystic swelling situated behind the hernial sac, and regarded by him at the moment as an isolated diverticulum of the sac, was opened. Its connection with the ureter was recognised by passing a sound along it for eight inches, by the mucous membrane lining the cyst, and by the escape of a tablespoonful of orange-coloured fluid. The cyst was freed from its adhesions and removed. The cut edges of the ureter were stitched to the abdominal wound. Intense pain and a hydro-nephrotic tumour in the right flank followed in a few days, and nephrectomy was in consequence performed.

Before abdominal surgery became so common, wounds of the ureters produced by surgeons and obstetricians were almost entirely limited to the accidents attending instrumental labour and to the treatment of vesico-vaginal fistula.

To-day there are few surgeons who have done many major operations on the pelvic and abdominal organs who have not had the misfortune once or oftener to divide, or even excise, a portion of a ureter, either through necessity or by accident.

I pointed out in the first edition of this work the liability of mistaking the spermatic or ovarian vein for the ureter, and also the great degree of varicosity I had seen in the spermatic vein in a case of tumour. Should these veins be emptied for the moment by traction or pressure, they look much like the ureter. Conversely, the ureter, whether dilated or not, may readily be mistaken for a vein. Glantenay and Regnier have more recently referred to this source of error.

In the case in which I divided the ureter through three-quarters of its circumference in the course of an abdominal hysterectomy,‡ the accident occurred through this mistake. I had ligatured and nearly divided the duct, thinking it was an enlarged vein, before I discovered that it was the ureter.

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* Von Rosthorn, *Centralblatt für Gyn.*, 1895.

† Berlin Congress of German Surgeons, 1892.

‡ "Hunterian Lectures," p. 38.

Such an accident occurring in the course of an operation, if detected at the time, ought to be immediately faced without waiting until books or authorities on the best mode of procedure can be consulted. It can, therefore, only be successfully grappled with by one who is familiar with the varieties and possibilities of treatment which recent experiments and isolated cases have brought to light.

Every surgeon who performs complicated abdominal operations ought to prepare himself beforehand for the treatment of these accidents by a study of the different operative methods by which they can be repaired.

Etiology.—That portion of the ureter which is within the true pelvis is by far the most frequently cut, divided, torn, or injured by clamp, forceps, or ligatures, but occasionally the abdominal portion suffers. Such injuries are almost always imputed to special difficulties present in each particular case, such as the extent or toughness of adhesions; the inclusion within the layers of the broad ligament of the tumour to be removed, or enlargement of the cervix uteri, due to the infiltration of cancer or its expansion by a fibroma.

Zweifel in 1892 pointed out that in vaginal hysterectomy, when the broad ligaments are tied off, the ureter is in danger of being compressed by the ligatured tissues, though not itself included in the ligature, and that necrosis and a subsequent uretero-vaginal fistula may result.

An accident of this kind happened in the course of an abdominal hysterectomy to Mr. Purcell,* by the ligatures applied to the uterine arteries: both ureters were occluded by compression of the surrounding tissues, though neither was included in the ligatures.

Ureteral injuries are, however, more likely to happen in the course of complete vaginal hysterectomy than in any other operation, and this is not surprising considering the close relation which exists between the terminal part of the ureter and the neck of the uterus.

Le Dentu, in the *Bulletin de Chirurgie,* November 4th, 1885, reporting a case of vaginal hysterectomy for carcinoma of the neck of the uterus, remarks that it is in the first stage during the circular section of the vaginal wall, and finally, when the forceps are placed and maintained on a vessel at the roof of the vagina, that injury to the ureter is most to be dreaded. The entrance of the ureters into the bladder is close to the artificial *cul-de-sac* which the two points of suture, applied to reunite the vaginal walls, form at the top of the vagina. To avoid this accident, the posterior face of the bladder and the terminal portion of the ureters ought to be most carefully separated from the anterior face of the uterus. By means of an anatomical preparation he showed how the lower part of the ureter is placed on the side and even in front of the neck of the uterus, and that it is not therefore in applying ligatures to the broad ligaments that the ureters run the greatest risk of being wounded, but in seizing small vaginal arteries, which cannot well be seen, and therefore cannot be tied under the guidance of the eye, with forceps which have to be retained for some time. These anatomical relations, as Le Dentu rightly says, ought always to be present in the minds of operators.

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* *Medical Press and Circular* June 1 1898.

The ureter may be damaged, either by being cut or torn or compressed. In Dr. Purcell's case * above referred to both ureters were so dragged upon by the ligatures applied to the uterine arteries that complete anuria followed the operation. After fifty-eight hours the abdominal wound was opened up and the ligatures removed. The ureters were seen to be ballooned by urine, which flowed off into the bladder as soon as the traction was relieved. The patient made an uneventful recovery.

M. Pozzi † speaks of three degrees of laceration: (*a*) simple lateral tear without solution of continuity; (*b*) complete tear, but without displacement of the torn ends; (*c*) complete rupture with laceration of one of the extremities. Most frequently the ureter is cut or torn completely across, and in not a few cases a portion of the tube is excised to the extent of one, two, three, or more inches. Loss of substance of the ureter naturally adds to the gravity of the case, since it makes any plastic operation with the view of restoring the channel all the more difficult, and in some cases leaves no alternative but the establishment of a fistula or the removal of the kidney.

Prognosis.—If the injury of the ureter is detected at the time of its infliction and a plastic operation is at once performed, the prospects are very favourable, both as regards the kidney and the life of the patient.

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* Purcell, *Medical Press and Circular*, June 1, 1898.

† *Ann. des Maladies des Organes génito-urinaires*, 1891, p. 339.

J. Wesley Bovée has collected eleven cases, including one of his own, to which I have to add one of mine, one of R. Winslow's, and one of F. H. Markoe's, thus in all making fourteen, in which these intercurrent surgical wounds, involving *complete division* of the ureter, have been treated, at once, by one or other of the methods of uretero-ureteral anastomosis.

Of these fourteen cases (*see* Tabular List, pp. 376-77) one subsequently underwent nephrectomy and two died: one on the twentieth day, from secondary hæmorrhage due to the original operation (Hochenegg's); and one at the end of seven weeks, from tuberculosis (Schopf's). Ten of the cases are reported as cured, and in one of the fatal cases (Hochenegg's), though the patient died of secondary hæmorrhage following the operation for removal of the uterus for cancer, the condition of the ureter is reported as satisfactory.

In the third fatal case (Schopf's), the ureter was embedded in connective tissue and the renal pelvis on the same side was distended, but in connection with this case it must be remarked that at the operation the adhesions, and with them the ureter, were divided by the thermo-cautery, and the two ends of the ureter were also temporarily compressed with forceps, so that as a consequence a great deal of new-formed tissue was developed which led to the peri-ureteral thickening.

In my own case the ureter was unintentionally divided with some dense adhesions in operating upon a case of movable and misplaced kidney. Van Hook's lateral anastomosis was followed by stenosis and nephrectomy.

The result of surgical treatment of *incomplete* division of the ureter, it is reasonable to expect, will be more favourable as regards the subsequent condition of the ureter than that of complete division. The number of cases at present recorded is, however, too few to allow of any comparison being made. Out of five collected cases (*see* Tabular List) there were two deaths, one from the effects of the operation during the performance of which the accidents to the ureter happened, the other from renal insufficiency; but in all the cases the condition of the repaired ureter was very satisfactory. In Pawlik's case and in my own the patients died too soon to judge of the ultimate result, but at the post-mortem examination the sutured ureters were patulous and water-tight. In my case injections under a very strong pressure were used to test the security of the union.

If the injury is not detected at the time of its infliction, the result will depend upon whether the urine escapes into the peritoneal cavity, into the vagina, or upon the cutaneous surface.

If the ureter is divided near its lower end and becomes engaged in the vaginal or uterine cicatrix, so as to form a uretero-vaginal or uretero-uterine fistula, or if its proximal cut end is engaged in the parietal cicatrix, the patient will have an unceasing escape of urine, which will greatly distress her and perhaps much impair her health; but life is not thereby threatened, or only remotely so, if at all, by the development of ascending septic changes which may finally culminate in suppurative pyelo-nephritis.

H. J. Boldt reports a case in which the kidney became infected through a uretero-vaginal fistula, and he was obliged therefore to perform nephrectomy.*

If the urine leaks into the peritoneal cavity and either the urine or the peritoneum is in a septic condition, a rapidly fatal peritonitis will result. If, however, both urine and peritoneum are aseptic, the urine is tolerated, is even in part absorbed, and no peritonitis ensues, at any rate for a time.†

In contrast therefore with the grave consequences of penetrating and subcutaneous wounds of the ureter, those made by the surgeon are relatively much less serious in their effect upon the kidney and the life of the individual. If made within the peritoneal cavity and the urine is aseptic they result in a simple urinary fistula, discharging at the line of the abdominal incision, or into the vagina, or else they lead to the formation of a circumscribed intra-peritoneal urinary abscess, terminating later on in a fistula discharging pus as well as urine. Even if the urine is septic, provided the ureter is divided low down and gets fixed in the vaginal cicatrix so as to establish a uretero-vaginal fistula, the patient incurs no additional immediate risk to her life from the wound in the ureter.

Symptoms and diagnosis.—Many of these injuries are detected at the time they are inflicted, but not all of them. If, for example, the ureter is included in the loop of a ligature, or is clipped by compression forceps, in the course of a vaginal hysterectomy, it is only on the separation of the slough that the discharge of urine through the vagina will commence. One or even both ureters may be cut or torn across during either vaginal or abdominal hysterectomy, and the injury not be detected until urine is found escaping into the vagina.

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* *Amer. Journ. of Obstetrics*, 1896, No. 33, pp. 844–858.

† Thornton's and Kammerer's cases support this statement.

I have witnessed the performance of total vaginal hysterectomy for carcinoma of the cervix uteri, in the course of which the operator divided both ureters without being conscious of what had happened till some hours after the patient was returned to bed. As she did not recover from the operation, the question as to the best means of dealing with the double uretero-vaginal fistula did not arise. In a case of abdominal hysterectomy in which one ureter was divided without the operator becoming aware of the accident until a day or two afterwards, it was difficult to determine which ureter was concerned in the uretero-vaginal fistula which resulted. Efforts by intra-vesical inspection, and attempts at ureteral catheterisation, failed to clear up the doubt, chiefly—as I was informed by the surgeon in charge—owing to the contracted state of the bladder, and the impossibility of ballooning it. Unhappily, the method of testing by the application of a temporary ligature round one ureter near the kidney led to a fallacious conclusion, with the sad result that nephrectomy was performed on the wrong side, and thus the vaginal fistula in connection with the ureter of the remaining kidney still continued.

If the injury is done during an intra-abdominal operation, and the abdominal wound is closed before the accident is detected, urine will leak into the peritoneal cavity, and will give rise to one or other of the following conditions:—

First, if the urine which escapes is septic, owing to calculous or tuberculous pyelo-nephritis, or pyelitis from any other cause, the symptoms of acute general peritonitis will rapidly arise.

Second, if the urine is healthy, it does not necessarily excite peritonitis, but may accumulate in the general peritoneal cavity, whence it will be in part absorbed; or it may pass through the peritoneal cavity and escape at the abdominal wound, as it did in Thornton's case; or

Third, the urine may accumulate in some particular part of the peritoneal cavity, and even if it is quite aseptic, may set up a subacute or chronic localised peritonitis, and after the lapse of some days or weeks, produce a circumscribed abscess followed by a purulent and urinous fistula at the spot where the abscess bursts or is opened.

This is especially likely to happen if urine, even quite healthy, comes into contact with a raw or blood-coated surface of bowel or with detached adhesions.

Kammerer reports a case of a young woman whose right ureter was injured during oophorectomy. Seventeen days after the operation, signs of peritonitis were developed, the wound was opened up and a localised cavity exposed from which a large quantity of sero-purulent fluid, with a urinous odour, escaped. A urinary fistula was established, for which lumbar nephrectomy was performed, and the patient recovered.

Treatment.—A great many ingenious operations—some of great difficulty and requiring attention to minute operative details—have been proposed or practised to remedy these serious accidents, and with the object of avoiding nephrectomy on the one hand and a ureteral fistula on the other.

After Simon first removed the kidney for a ureteral fistula following an injury to the ureter during an ovariotomy, nephrectomy became the common treatment in such cases; it has also, on several occasions, been performed as a primary operation for surgical injuries of the ureter detected during the course of an operation.

But with our present experience of plastic surgery of the ureter, it ought only to be resorted to in wounds, or for fistula following wounds of the ureter, when the state of the kidney itself happens to be prejudicial to health, or when the surgeon, having tried and failed by plastic operation, has given up the attempt to repair the injury and save the kidney. Many of the procedures which have been tried have failed in their object, but others have succeeded, and give promise of still greater success.

A transverse division of the ureter is much more difficult to repair and much more serious in its consequences than a longitudinal incision, (1) on account of the tendency of the ends to retract and gape, and (2) because of the stenosis, and contraction of the ureteral walls, and the compression from the condensed surrounding cellular tissue which are apt to occur after union has taken place.

Excision of a portion of the ureter gives rise to further difficulties if the loss of substance is too great to allow of uretero-ureteral anastomosis, or of what is the best substitute for this, namely, uretero-vesical grafting. Still, anastomosis has been successfully accomplished where one or even two inches of the duct has been excised; for the ureters are very elastic, and capable of considerable elongation, if the ends are not involved in adhesions, or bound down by condensed connective tissue. The various plans which have been adopted in cases of *complete division, or excision of a part of the ureter*, are the following:—

1. Tying both ends and dropping them back into their positions.

2. Tying the distal end and suturing the proximal end to the abdominal wall. This is really ureterotresis, because it establishes a permanent opening with the ureter.

3. Uniting the divided ends by one of the forms of uretero-ureteral anastomosis.

4. Grafting the end of the ureter to the bladder.

5. Grafting the end of the ureter into the bowel.

6. When the distance of the cut end of the ureter from the bladder renders it impossible, without great traction, to join the two, the bladder has been detached from the back of the symphysis pubis; or the bladder has been fixed by suture to the pelvic wall close to the stump of the ovarian artery (Baldy); or a diverticulum of the bladder has been created long enough to allow of implantation into it of the end of the ureter (Witzel).

7. Nephrectomy.

Other methods have been suggested and tried on animals, but have not been carried out, so far as I know, in the human subject. Thus, it has been proposed to meet the deficiency in the length of the ureter—

8. By bringing down the kidney and fixing it at the level of the iliac crest (Bovée). In the case of a movable kidney, this plan would probably be very feasible.

9. By fastening both ends of the ureter into the external wound, under considerable tension, and a month or so later, when the ends have become stretched, anastomosing them (Monari).

10. By establishing a continuous channel between the two ends of the ureter after they have been implanted into the abdominal wall; the tissue employed to make good the deficiency being skin (Rydygier) or cellular tissue.

11. By employing for this purpose the peritoneum of the back of the bladder, or a splice from the bladder wall itself (Van

Hook), without previously stitching the ends of the ureter to the surface of the abdomen.

Uretero-ureteral anastomosis.—If the injury is recognised at the time, and the condition of the patient and the nature of the injury will permit, the proper course is to repair it by one of the methods of uretero-ureteral anastomosis.

Four methods of anastomosis have been employed: (1) The end to end; (2) the end in end; (3) the lateral implantation; (4) the oblique end to end. These operations are described in detail in the chapters on "Plastic Operations on the Ureter" (*see post*, p. 531). Out of fourteen cases of *complete division* which have been treated by the above methods, six were by the *end to end* plan, four by *lateral implantation* (Van Hook's operation), three by the *end in end*, and one by the *oblique end to end* union (*see* Tabular List overleaf).

Out of five collected cases of *partial division* the wound was closed in three by silk sutures passed in the manner of Lembert—in one of these two rows of sutures were used and the wound line was afterwards covered by peritoneum. In each of the other two cases also sutures were employed.

Eleven out of the fourteen cases of *complete division* are reported as recovered or cured; one subsequently had to undergo nephrectomy. In one of the successful cases (Cushing's) in which the *end to end* operation was performed, only one catgut and two fine silk sutures were used; urine was discharged by the wound on the fourth day, and a fistula remained for nine months.

The two fatal cases were *end to end* operations, but the operation had nothing to do with the cause of death. In one of them, at the end of twenty days, the ureter sutures were found intact after death, in the other case the ureter at the end of seven weeks was stenosed, and the corresponding kidney contracted to the size of a hen's egg and its pelvis distended. Had this latter patient lived it is most likely the kidney would have become entirely destroyed by the stenosis of the ureter, which at the seat of the union resembled a linear cicatrix embedded in connective tissue. Franz Schopf's case was the first in which uretero-ureteral anastomosis for section of the ureter was carried out. The patient was a woman, aged thirty-nine, who was operated upon for an ovarian tumour connected by many tough adhesions with the uterus, broad ligament, and wall of the pelvis. The two ends of the divided ureter, which were deeply buried in fibrous

WOUNDS OF THE URETER TREATED BY URETERO-URETERAL ANASTOMOSIS.

COMPLETE DIVISION.

No.	Date.	Surgeon, and source of information.	Method.	Nature of original operation during which the injury to ureter occurred.	Result.
1	1886	Schopf: Bovée's paper, *Annals of Surgery*, 1897, vol. xxv., p. 57.	End to end; eight silk sutures. Operation performed in 1886.	Ovariotomy.	Death in seven week from tuberculosis. Pelvis of kidney distended; ureter embedded in cicatricial tissue.
2	,,	Tauffer: Bovée's paper, *vide supra.*	End to end; from six to eight sutures over No. 8 catheter, which was removed.	Intra-ligamentous cyst.	Recovered.
3	,,	Tauffer: Bovée's paper.	Ditto.	Extra-peritoneal tumour.	Recovered.
4	,,	Fritsch: Bovée's paper.	End to end; fine intestinal suture.	Abdominal tumour.	Recovered.
5	1890	Hochenegg: Bovée's paper.	End to end.	Cancer of uterus. Sacral operation; hysterectomy for cancer.	Death on the twentieth day from hæmorrhage. Ureter sutures intact.
6	1893	H. H. Kelly: *Annals of Surgery*, 1894, vol. xix., p. 70. Bovée's paper.	Van Hook's lateral implantation; oblique section of the upper end to avoid contraction of its orifice. Van Hook's paper, March 4th, 1893. Kelly's operation, May 1st, 1893.	Uterine myoma.	In good health three years after. Kelly's "Operative Gynæcology," vol. i., p. 466.
7	,,	E. W. Cushing: Abstract, *Annals of Surgery*, 1894, vol. xix., p. 757. Bovée's paper.	End to end; sewn together with two silk sutures, one catgut.	Soft myoma of uterus.	Fistula developed from the fourth day and closed in nine months. Perfect in result five years later. Bovée: *Annals of Surgery*, 1897, vol. xxvi., p. 317.
8	1894	B. Emmett: *American Journal of Obstetrics*, April, 1895, vol. xxxi., p. 449. Bovée's paper.	Van Hook's; modified by using three sutures instead of one to get dilated upper end into lower, and continuous suture over.	Large œdematous fibroma of uterus.	Left ureter divided opposite fifth lumbar vertebra. Catheter in bladder six days. Recovery.

9	1895	Doherty : Private letter to Van Hook. *Journ. Am. Med. Assoc.*, Nov. 16, 1895.	Van Hook's method of lateral implantation.	"During a laparotomy." No details given.	Recovered.
10	1896	Mayo Robson : Bovée's paper.	End in end ; two inches of ureter removed in operation.	Uterine myoma.	Well six months later.
11	,,	Bovée : *Annals of Surgery*, vol. xxv., p. 317.	Oblique end to end ; one inch shortening.	Abdominal tumour.	Catheter every six hours. Recovery. Well eleven months later.
12	1897	R. Winslow : *Annals of Surgery*, Jan., 1898, vol. xxvii., p. 46.	End in end ; two traction sutures used.	Abdominal tumour.	Recovered.
13	1899	Henry Morris.	Van Hook's method.	Original operation undertaken to fix movable and misplaced kidney.	Lumbar nephrectomy a month afterwards, on account of extravasation of urine and urinary fistula which formed on the eleventh day after early promise of doing well.
14	1897	Francis H. Markoe : *Annals of Surgery*, June, 1899.	End in end over a catheter.	Panhysterectomy ; ureter mistaken for a large vein.	The operation was performed on Nov. 24, 1897, twenty-four hours after the injury. Catheter retained for five days. Recovery at end of a little over a month.

PARTIAL DIVISION.

1	1888	Pawlik : Bovée's paper.	Double row (Lembert) of silk sutures over ureteral catheter, which was left in ; a covering of peritoneum was formed.	Papillomatous cyst of ovary.	Death in fourteen hours from shock. Ureter satisfactory. No leakage.
2	1895	Westermark : *Annals of Surgery*, 1896, vol. xxiii., p. 339.	Direct suture.	Abdominal tumour. Sacral hysterectomy.	Primary union of ureter.
3	1897	H. Morris : Hunterian Lectures, *Brit. Med. Jour.*, 1898, vol. i., p. 878.	Divided through $\frac{3}{4}$ of circumference. Fine silk sutures *à la* Lembert ; peritoneal covering.	Abdominal hysterectomy.	Death in fifty-one hours. Both kidneys extremely hydro-nephrotic. Union secure at post-mortem examination, as tested by forcible injections.
4	1898	Hindley : Quoted by Winslow, *Annals of Surgery*, Jan., 1898, vol xxvii., p. 46.	Sutured.	Abdominal tumour.	Two weeks later a urinous infiltration into the broad ligament was opened from the vagina and drained.
5	,,	Lawford Knaggs. *Lancet*, May 27, 1899.	Half-divided. Lembert's sutures.	Multilocular cyst of right ovary, and a proliferating papillomatous cyst of left ovary.	Urinary fistula formed seven weeks after operation ; closed quickly. Well $11\frac{1}{2}$ months after.

tissue, were dissected free for a short distance and brought together by eight silk sutures passed through the fibrous and muscular but not into the mucous coats. This operation was performed by Schopf in 1886. The patient died of tuberculosis seven weeks after the operation. The stenosis of the ureteral union might have been conduced to by the use of the thermo-cautery to burn through the adhesions in which the ureter was embedded. We have yet to learn the subsequent condition of the kidney in other cases in which recovery without a fistula has followed the ureteral union.

All these methods of anastomosis, though for a time apparently successful, are, it is to be feared, likely to be followed by early fistula, or later by stenosis of the ureter and hydro-nephrosis or atrophy of the kidney, when the accident involves a ureter which is of small calibre or even when the ureter is of natural average size.

Fortunately in many cases in which during abdominal operations this serious accident has occurred or is likely to occur, the ureter has been and will be found dilated, and thus the anastomosis will be easier to effect and will not be followed by occlusion or stenosis of the ureter. Even Van Hook's method, the least likely to give rise to fistula or stricture, which has been performed successfully on three women and which led to no contraction or stenosis in experiments on dogs, has in my hands, in a case where the ureter was very thin and of very small lumen, resulted in a fistula on the eleventh day after the operation, though everything up to that date promised complete success.

The *end to end* method, as we have seen in Schopf's case, resulted in stenosis, and Büdinger's experiments on dogs with this method gave deplorable results. The *end to end* method seems to have been successful in four cases and to have given promise of success in a fifth had the patient survived. It necessitates perfect coaptation, exact apposition of the cut ends, and the careful employment of Lembert's sutures minutely applied, if success is to be obtained; then, if the patient is healthy and repair takes place rapidly and without any excessive exudation around the union, there is no reason why stenosis should occur; but it does not seem to offer the same security against fistula and stricture as the lateral anastomosis of Van Hook.

Although the *end in end* plan has in two women been followed by success, this was no doubt largely due to the fact that the ureters involved were dilated. When not dilated this method (the *end in end*) ought certainly not to be adopted; it was the plan of procedure employed by Tuffier in his experiments on animals, with results which he himself condemned in unmeasured terms. Poggi's experiments with it on dogs on the contrary are described as eminently successful.

Tuffier's * plan of procedure for transverse wounds in his experiments on animals was an end in end method. After freeing each of the cut ends to an extent of 1 cm. from their surrounding fatty and vascular tissue, he dilated the cut end of the lower segment and drew the end of the upper segment into the lower and held it there by means of two or three points of modified Jobert's sutures. When these were tightened the superior end was invaginated into the inferior end, but there was generally faulty adaptation, due to the incessant retraction of the upper end, so that he employed Lembert's sutures in the intervals between Jobert's. Finally, he united by some buried catgut sutures the fatty peri-ureteral tissue. All the experiments were made across the peritoneal cavity through an incision along the outer border of the rectus muscle. If the sutures were not perfectly applied the dog died of peritonitis in five days.

Tuffier points out that it is the cellular tissue layer of the ureteral wall which forms the cicatrix. The muscular coat provides a good holdfast for the sutures, but is not vascular enough for rapid union. The peri-ureteral tissue contains numerous feeding vessels and forms a veritable nutritive membrane, so that if it is too extensively denuded the ureter is liable to slough.

Whilst Tuffier obtained satisfactory results in his experiments on longitudinal wounds, with the transverse wounds the results, according to his own statement, were deplorable. Either a fistula or a stricture followed: out of six experiments four resulted in fistulæ and two in strictures. In each of the stricture cases the ureter above the seat of operation became greatly dilated.

These failures were due partly no doubt to the small size of the ureter of the dog, but chiefly to the technique of the operation.

Precautions requisite in uretero-ureteral anastomosis.—In adopting any of the forms of uretero-ureteral anastomosis certain precautions are requisite. (*a*) The ends of the ureter should be protected from further injury till the surgeon is ready to commence uniting them; this is best done by packing gauze or small sponges about them. (*b*) Search should be made with a ureteral sound or catheter as to the permeability of the duct throughout its length, as it would be useless to waste time in making the anastomosis if the ureter was obstructed elsewhere and the obstruction could not be relieved. (*c*) As the urine may be septic, and if so will be likely to infect the peritoneum, it should be prevented from escaping by guarding the proximal end with a clamp or temporary ligature very lightly applied, until the union of the ends is completed. (*d*) Search may be made for any congenital abnormality of the ureter, but this is not actually necessary, because even if there existed a double ureter in part of its course, or even throughout, it would be necessary just the same to effect the union of the ends of the divided duct, inasmuch as when two ureters come off from the same kidney they usually act as separate conduits for certain calyces and not as common ducts for the whole kidney. (*e*) Drainage by means of gauze and glass tube was employed by Tauffer, Kelly, Cushing, and Knagg; but though it is not necessary in intra-abdominal cases it should be maintained for a few days in cases of retro-peritoneal wounds. (*f*) When the division of the ureter is quite low down a catheter should be retained in the bladder for two or three days in order to prevent strain upon the sutures by back flowing of urine from the bladder. The retention of a catheter with antiseptic drainage of the bladder is better than the intermittent use of the catheter, because it is during the accumulation of urine in the bladder, not when the bladder is distended, that this back flow is likely to occur. In Kammerer's case, above alluded to, water injected into the bladder could be made to flow out of the ureteral fistula until the bladder was full, and then it ceased to escape. Such a back flow is certainly not constant, probably not possible when the ureteral orifice is normal. A case is reported by M. Desnos in which, after nephrectomy, a little urine was discharged through a persisting fistula at each act of micturition. This would seem to show that the muscular contractions of the bladder can drive urine up into the ureter as they do through a patent urachus; but the conclusion is more than doubtful. In Desnos' case there was a suppurating cavity into which urine probably escaped whilst the bladder was filling and from which it was driven by abdominal, not by vesical muscular contractions during micturition.*

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* "Études Expérimentales sur la Chirurgie du Rein," 1889.

Ureteral grafting.—Implantation or grafting of the ureter into the bladder or bowel.—When the ureter is injured in its pelvic part it may be very difficult or even impossible to suture the divided ends, or even to close a longitudinal incision; or the ureter may be divided so near the bladder that vesical grafting is not only more easy of performance, but more likely to succeed than uretero-ureteral anastomosis; or again, if 2½ inches or more of the abdominal portion of the ureter have been excised, neither uretero-ureteral anastomosis nor vesical grafting will be possible, and the question of uretero-intestinal grafting will then have to be considered.

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* *Archives Générales de Médecine*, Nov., 1899, p. 563.

Grafting into the bladder is the ideal operation when uretero-ureteral anastomosis is not feasible, and, as just stated, when the injury involves the pelvic part of the duct, vesical grafting is even preferable to uniting the ends of the ureter. If neither anastomosis nor vesical grafting is possible, as in cases of the loss of part of the abdominal or upper pelvic sections of the ureter, or when the ends of the ureter are embedded in tough fibrous tissue, grafting into the lower end of the ileum, into the colon, or the upper part of the rectum may yet be possible. Grafting into the middle or lower parts of the rectum is not likely to be indicated in wounds of the ureter, because if the conditions permit of this they would equally allow of vesical grafting.

In every variety of grafting the distal end of the divided ureter had best be ligatured.

Special objections to uretero-intestinal grafting.—There are exceptional objections to all forms of intestinal grafting. Not only are there the ordinary risks of stenosis of the ureteral orifice and of ascending septic infection—dangers common to all forms of implantation, even the vesical—but the danger of infection is especially great—so great in Van Hook's opinion as to render uretero-intestinal grafting an unjustifiable operation.

Boari, on the other hand, regards the operation with favour, and believes that the free flow of urine through the ureteral orifice is a protection against the risks of infection. Chaput has had successes with uretero-colic grafting in women. I am inclined to think, from the length of time vesico-intestinal fistula, with passage of fæces through the bladder, but without causing ascending septic infection of ureters and kidneys, has been present in certain cases of cancer of the bowel under my care, that the special dangers of infection in uretero-intestinal implantation as shown to exist by experiments on dogs have been over-estimated by Van Hook and Bovée as arguments against the operation in the human subject. Certainly it would be a great boon in ectopia vesicæ and cancer of the bladder if future experience should prove that uretero-intestinal grafting can be performed without submitting the patient to too great a risk.

There is probably less risk in uretero-colic than in uretero-rectal grafting, because of the constant onward passage of the contents in the higher portions of the bowel, whereas in the rectum fæces and foul gases linger for long periods and exercise considerable pressure upon the walls of the gut. There is, too, in uretero-colic grafting less necessity for constant evacuation from the bowel from the accumulation of urine just above the sphincter ani—a cause of distress and discomfort in some cases of uretero-rectal fistula.

Could it be shown that the risks from infection of uretero-intestinal fistula are not much greater than those of uretero-cutaneous, the former operation would, of course, be preferable, as it obviates an obnoxious and distressing external discharge of urine. The uretero-cutaneous, unlike the uretero-vaginal fistula, is not amenable to implantation of the ureter into the bladder.

If septic infection of the kidney should follow, secondary nephrectomy is a last resource equally whether the fistula opens into the bowel or vagina, or on the skin surface.

In grafting the ureter to the bowel there is the further danger of infecting the peritoneum by the escape of intestinal gases and fæces during the course of or subsequently to the completion of the operation. This is more especially liable to happen when the grafting is into the small intestine, owing to the mobility of the bowel. In all the experiments made by Byrom Robinson of grafting the ureter into the small intestine the animals died from peritonitis. Moreover, considerable time is necessary to carry out the details of the technique requisite to prevent such escape, and this of itself may be sufficient to render this form of grafting undesirable or impossible in certain cases.

When the ureter is injured during the course of a long operation, the patient's power of endurance may not be equal to the additional tax made upon it by so tedious and delicate a procedure as uretero-ureteral anastomosis, or ureteral grafting. Moreover, the operator may be too wearied to commence so delicate a task as the accurate and efficient application of sutures to a tube only 3 or 4 mm. in diameter, situated in the back of the abdomen or in the depths of the pelvis. Under these conditions other courses are open to the surgeon. Either he may graft the proximal end of the ureter to the skin or to the vagina, after ligaturing the distal end; or he may ligature both ends of the divided ureter, or perform nephrectomy.

Cutaneous and vaginal grafting.—These are not alternative operations. When minutes are of importance in concluding a long and difficult operation on account of the condition of the patient, the proximal extremity of the ureter should be turned into the vagina with a view to future uretero-vesical grafting, if the duct is wounded low enough down in the pelvis, as it is in vaginal hysterectomy and certain cases of abdominal hysterectomy, ovariotomy or oophorectomy.

When the ureter is wounded too high up for this, the end or ends of the ureter should be detached for a few inches from its or their bed and brought up and fixed to the skin either through a stab wound in the loin, or on the side of the abdomen, or through the operation wound on the front of the abdomen, with the view of a future plastic operation, or of establishing a permanent cutaneous fistula; or if the involved kidney is much diseased, or atrophied from long-standing obstruction, with the view of performing nephrectomy when the patient has sufficiently recovered from the original operation.

If a subsequent plastic operation is contemplated, circumstances must determine which kind of operation will be adopted (*see* chapters on Operations on the Ureter).

Implantation on the loin or the front of the abdomen with a view to a permanent fistula results in a very miserable condition which many patients would gladly be rid of even at the sacrifice of one kidney, provided the other is sound or fairly so. But in many cases in which these accidents happen both kidneys have seriously suffered from long-standing obstruction due to the pressure of the tumour for which the original operation was undertaken; the kidney belonging to the injured ureter may be the better of the two, or even the only one which is functionally active. Under these circumstances, especially if the ureter is injured very high up, a cutaneous fistula is the only means of saving life. I suggested this in 1884, when writing the first edition of this book, and then gave reasons for preferring the loin to the front of the abdomen as the place for establishing the fistulous opening, as the following passage shows:—

"In the removal of ovarian and uterine tumours, the ureter has on several occasions been divided, and it would have been well in these accidents if the renal part had been brought out through a wound made for the purpose in the loin of the same side, and its orifice there attached by sutures, so as to be outside the peritoneal cavity."

Agnew* mentions a case in which the ureter was accidentally divided in removing an adherent ovarian cyst. The renal end was secured in the external wound, and a urinary fistula formed. The patient lived several months, and finally died of some obstruction in the course of the duct.

The great objection to bringing an elongated cord-like structure out at an anterior abdominal wound is lest it should cause subsequent intestinal obstruction. This is no theoretical objection, as it has been sometimes stated to be. It has proved itself to be an actual source of danger; and though, like other sources of danger, it is not always followed by evil consequences, it is a risk to which the surgeon ought not to expose a patient.

Uretero-cutaneous fistula, like uretero-vaginal and uretero-intestinal fistula, exposes the patient to the risk of ascending septic infection resulting in uretero-pyelo-nephritis, but scrupulous cleanliness may do much to prevent this. There are two persons living upon whom I established loin fistulæ years ago, one in 1884 and the other in 1894; both are well at the present time, with their fistulæ discharging urine, and neither has ever had any sign of ascending infection. But it will occur surely and fatally if strict attention to the toilette of the orifice is not observed, and its occurrence gives strong support to Boari's opinion as to the paramount importance of the normal ureteral sphincter.

In none of the varieties of grafting, not even the vesical, can we obtain the safeguards which nature has provided against the dangers of ascending infection. Neither the muscular mechanism described by Bell nor the mucous fold at the normal vesical orifice of the ureter has hitherto seemed possible of reproduction in any of these operations. The obliquity of the transit of the ureter through the wall of the bladder is capable of being imperfectly imitated. In the case of implantation into the bladder the sphincter vesicæ, it is true, protects the ureter to a great extent against the entrance of septic organisms, so long, at least, as the bladder itself remains healthy. But in none of the other varieties of implantation is there even this amount of security against uretero-pyelo-nephritis from infection through the ever patent orifice of the engrafted ureter. The importance of the normal ureteral orifice is such that in some very exceptional cases in which the greater part of the bladder has been excised for malignant or tuberculous disease, the portion of the bladder wall surrounding the ureteral orifices has been saved and implanted with the ureter into the rectum, with the object of preventing the danger of renal infection.

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* "Principles and Practice of Surgery," vol. i., p. 376.

Allusion has been made already to the fact that in uretero-vesical implantation, regurgitation of urine occurs. This is more especially prone to happen when precaution is taken against the occurrence of stenosis by splitting the engrafted end of the ureter. Stenosis, or too great a contraction of the ureteral orifice, is one of the dangers of all forms of ureteral implantation, whether into the bladder, bowel, or vagina, or on the surface of the skin. Such stenosis results in hydro-nephrosis, which has been a very common sequel of all forms of experimental ureteral grafting. It has been more especially in cases of uretero-intestinal operations on the human subject, and similar experiments on animals, that nephrectasis (hydro-nephrosis and pyo-nephrosis) has occurred.*

Ligation of both ends of the divided ureter.—When it is essential on account of the patient's condition to complete an operation as quickly as possible, and if the kidney of the uninjured side is known to be sound, it has been recommended to ligate the injured ureter and leave it *in situ*, as Bardenheuer did in the following case: A female, forty-eight, weak and extremely emaciated, had suffered for a long time from malignant ulcer of the cervix uteri, which had extended 1½ to 2 cm. along the vaginal wall. Bimanual examination showed the bladder and right ureter to be free. On the left side, the ureter passed close to the new growth, so that it was just doubtful whether extirpation of the disease in the vaginal wall could be undertaken without removing part of the ureter. Total extirpation of the growth was carried out in the quickest way, as described. The portio vaginalis, so far as it was affected, was cut round before the operation proper was commenced, so as to render the procedure easier. The left ureter passed through the growth, and its section could not be avoided. Under these circumstances there remained nothing but to undertake the extirpation of the kidney at once, or to ligature the ureter. The latter was done. Good recovery followed in six days, but rigors and death ensued in the eighth week from pyuria, arising from the extra-peritoneal incision.

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* *See* T. Smith's case, *St. Bartholomew's Hospital Reports*, 1879; and the report of the experiments of uretero-intestinal grafting on dogs by Paoli and Basachi, by Bardenheuer, by Morestin, and by Harvey Reed.

If ligation of the ureter is adopted both ends should be secured, otherwise, especially if the vesical orifice of the ureter is abnormal, urine may regurgitate through the distal cut end, as in Modlinsky's, Pozzi's, and Desnos' cases. Ligation is too uncertain in its result upon the kidney to justify its unqualified acceptance as a means of simply causing extinction of the secreting function and complete aseptic atrophy of the kidney; but it is useful, at any rate, as a temporising measure in cases unfavourable to any plastic operation, in which a cutaneous fistula has to be avoided, and when the shock of primary nephrectomy might prove fatal.

Guyon, from the result of his experiments on dogs,* holds that aseptic atrophy of the kidney follows from aseptic obliteration of the ureter, and he thereupon repeats a previously expressed opinion, viz. that it is better when the ureter is torn or divided during an abdominal operation to apply an aseptic ligature to the ureter, rather than resort to nephrectomy on persons who will not bear a prolonged operation.

Guyon's conclusion as to the effect on the kidney of aseptic ligation of the ureter is fortified by the results of similar experiments of Cohnheim, Strauss, Albarran, Germont, and Byrom Robinson; but Wladimiroff,† although as a rule he found from experiments that obliteration of the ureter produced a simple hydro-nephrosis, yet in two cases out of nineteen, pyonephrosis was developed. It may be that the kidney in these cases was already septic, or there may have been some failure in the asepticity of the ligature or operation. Byrom Robinson‡ ascertained that when the ureter is completely and for ever occluded, the corresponding kidney undergoes complete atrophy in a few months; but he points out that the kidney will bear complete occlusion of the ureter for several weeks and then resume its function on removal of the obstruction. He also found that the ligature was apt to cut through the ureteral wall and produce a ureteral fistula. In other cases the ligature on the ureter yielded a little, and sufficiently so to allow the urine to trickle through; in such cases, the obstruction becoming partial instead of complete, hydro-nephrosis was produced.

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* "Influence de la Tension intra-rénale sur les Fonctions des Reins," *Annales des Maladies des Organes génito-urinaires*, 1892.

† *Zeitschrift für Geburtshülfe und Gynäkologie,* 1893.

‡ *Annals of Surgery,* vol. xviii., 1893, p. 407.

Rose Bradford also, by his experiments, has recently shown that the kidney will resume its function after ligation and division of the ureter; but in three out of twelve experiments the fluid which escaped from the kidney when freed from obstruction was purulent.*

If painful distension or suppurative pyelo-nephritis, or nephrectasis—whether hydro-nephrosis or pyo-nephrosis—should follow the ligation, secondary nephrectomy can be performed. To avoid infection of the ureter and kidney, care must be taken to protect the proximal end of the ureter during the operation, and to employ an aseptic ligature on the ureter.

Primary nephrectomy.—As to primary nephrectomy for wounded ureter it may be stated absolutely that it is unjustifiable, unless it is known that the kidney involved is hopelessly diseased. Moreover, if the state of the patient renders the prolongation of anæsthesia requisite for a plastic operation dangerous, a fatal result will almost certainly quickly follow from the shock of nephrectomy.

In a case under Bardenheuer in which the kidney was removed through the loin at the same sitting, the patient appeared to do well at first, but died the following day of collapse. After the operation the urine was very scanty, and at the post-mortem examination the heart and remaining kidney were found to be in a state of fatty degeneration.

Secondary nephrectomy is a last resource and ought to be reserved for cases in which the kidney becomes disorganised by ascending septic infection, or by hydro-nephrosis after the adoption of any of the plastic methods, or for cases in which the surgeon, having tried and failed to cure a ureteral fistula, feels himself compelled to give up further attempts.

Treatment of partial division of the ureter.—For transverse wounds which do not completely divide the ureter, but involve a third or more of its circumference, Van Hook has proposed the following operation: "Make two longitudinal incisions in the ureter with a pair of small scissors, beginning at the middle of the wound to be closed. These incisions should be equal in combined length to twice the transverse diameter of the tube. Round off the sharp angles of tissue with the scissors, and suture longitudinally" (*i.e.* in the direction of the long axis of the tube) "with the object of producing a very wide instead of a very contracted lumen." When the wound involves the peritoneal side of the duct (as it necessarily does in accidents during abdominal operations), he advises that the union should be protected by surrounding it with a fold of peritoneum. Fenger and Emmet are of opinion that even for incomplete transverse wounds, when intraperitoneal, it will be safer to divide the ureter completely, and then resort to Van Hook's method of lateral implantation, which they regard as a tried and successful operation.

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* See *Pathological Soc. Trans. Lond.*, Dec. 11, 1897.

When the ureter is dilated it is sufficient, in my opinion, to close the wound by very fine silk sutures, passed in the fashion of Lembert, and then to cover the line of union with peritoneum. This was the method adopted by Pawlik, myself, and Knaggs, with complete success, so far as the restoration of the ureter was concerned. A mere puncture, or a wound involving less than a third of the circumference, may be securely closed by one or more Lembert's sutures and a covering of peritoneum, even if the ureter is not dilated.

It is not necessary to conclude with Van Hook that every incomplete transverse section of the ureter, when closed either by cicatrisation or by primary union after direct suture, will have a tendency to result in stenosis. In many of the cases in which the ureter is injured during an intra-abdominal operation, the ureter is dilated; and when this is the case, the results hitherto obtained justify me in recommending simple direct suturing with the stitches of Lembert.

Longitudinal wounds of the ureter.—These are very rarely produced accidentally. They are, however, at the present day, frequently made by the surgeon for removal of calculi; for division of valves of the mucous membrane of the ureter or renal pelvis at its junction with the ureter; and for strictures, and stenosis of the duct, the result of peri-ureteritis.

Some of these wounds are behind the peritoneum, as, for example, ureterotomy for calculi or stricture, or for the introduction of a ureteral catheter or bougie, to test the patency of the duct. Others involve the peritoneum, as in trans-peritoneal ureterotomy for calculi.

Extra-peritoneal longitudinal wounds, if uncomplicated and drained through the loin, heal very readily without being sutured. These wounds heal by granulation, without subsequent contraction. The mucous membrane tends to prevent the formation of granulations within the lumen of the tube, and the proliferation of epithelium over the granulations, between the edges of the incision, has a tendency to cause an increase rather than a contraction of the lumen of the duct, just as often occurs after external urethrotomy for stricture of the urethra. The practical inference drawn by Van Hook is that longitudinal wounds are best treated by the open aseptic method.

Opinions differ as to the employment of sutures in extra-peritoneal longitudinal wounds. For reasons given in another place (*see post*, p. 621 *et seq.*) I am an advocate for them, passed either transversely or in the Heinecke-Mikulicz manner, according to circumstances, unless the lumen of the ureter is very small, and the walls are very thin. Extreme tenuity of the ureteral wall renders it difficult, if not impossible, to pass sutures without penetrating the mucous surface; but if the walls are fairly thick, and the wound a very short one, such as is usually made in ureterotomy for calculus or in dividing a ureteral stricture, sutures passed in the Heinecke-Mikulicz manner will increase the lumen of a narrow ureter at the damaged point.

Tuffier,* in his experiments on dogs, used transverse interrupted sutures, passed after Lembert's method; only two out of four of his cases succeeded, however, without producing narrowing of the lumen. The sutures were passed through the thickness of the wall, but not into the cavity of the ureter. They were passed at right angles to the long axis of the ureter, at distances of not more than 2 or 3 mm. apart; six or seven being used to close an incision of 2 centimetres.

Intra-peritoneal longitudinal wounds must be united by sutures, and the line of suture should be covered with a fold of peritoneum stitched over it; or if the peritoneum is not lax enough to fold over the union, an omental graft should, if possible, be made available to cover the line of wound in the ureter.

Interrupted transverse sutures should be employed if the wall of the duct is fairly thick and the lumen of good average diameter, or if the ureter is dilated. But if the lumen is very small or the wall is thickened and stenosed, sutures passed after the fashion of Heinecke-Mikulicz are best. The suture material

* "Études Expérimentales sur la Chirurgie du Rein," 1889.

should be silk of very fine twist; the needles should be very delicate. The ordinary straight seamstress needles called No. 9 are recommended by Van Hook to be used with silk of such fineness that it easily passes through the eye of the needle.

I have often found it more convenient to use a small curved needle, the curve being the arc of a circle of three-quarters to one inch diameter. Hagedorn's needles can be used if the ureteral walls are thick, but if not a curved needle flattened on the curve or a straight round needle is preferable.

Van Hook describes the technique of suturing intra-peritoneal longitudinal wounds as follows: Keep the intestines and other viscera out of the way with suitable compresses. The patient should be in the Trendelenberg position. The injured ureter should be exposed, and if feasible an assistant should support or elevate it. Transverse interrupted sutures through the connective tissue and outer muscular layers should be passed after Lembert's plan. Finally the peritoneum must be accurately adjusted about the ureter by either of the following methods: "The first and best is by lifting the tube gently into the cavity of the peritoneum, drawing the serous membrane carefully behind the ureter, and after pulling the peritoneum around the ureter stitching it in a position to permanently enclose and protect the vessel.

"Secondly, the ureter may be involved in a completely detached fold of omentum which is loosely attached by a stitch to the connective tissue about the ureter.

"This method is obviously less secure than the first, since the omentum is deprived of its blood supply."

Lane used a continuous silk suture with perfect success in his case of trans-peritoneal uretero-lithotomy. Urine should be prevented from getting into the peritoneal cavity during the course of the suturing by having a flat sponge or some aseptic gauze between the field of operation and the general peritoneum.

CHAPTER VII.

URETERITIS AND PERI-URETERITIS.

The ureter, from the intimate incorporation of its several coats with the kidney—the direct continuity of its mucous and muscular coats with the renal pelvis and calyces, and of its fibrous coat with the investing capsule of the kidney—would naturally be expected to share in the inflammatory lesions of the kidney, and equally with the kidney to communicate inflammation from its own substance to the loose packing of cellular tissue which invests it.

At the other end of the canal the conditions are much the same, but with a difference: the fibrous muscular and mucous coats of the ureter are continued into the corresponding coats of the bladder; in fact, the half of the bladder may be regarded anatomically as an expansion of the lower end of the renal duct of the same side, so that any irritation or infective process can be conveyed from one viscus to the other by continuity of structure. The difference is that the natural aperture of communication with the bladder is minute and valvular, alternately opening and closing—instead of being habitually open and widely funnel-shaped like the infundibulum connecting the ureter with the renal calyces.

The usual classification of inflammatory forms which attack the kidney and bladder, into the simple or catarrhal, the suppurative, infective, hæmorrhagic, pseudo-membranous and tuberculous is equally applicable to the forms of ureteritis; whilst every kind of change which takes place in the perinephric tissue as secondary to renal affections is imitated in the peri-ureteral tissue as the result of ureteral diseases.

With the exception of tuberculous disease, which will be described separately, it is not intended to adopt any such classification in the following description of ureteritis, but to make a simple division merely with reference to the seat of origin of the inflammation. Thus we shall speak of the following varieties :—

1. Primary ureteritis, idiopathic and traumatic.
2. Secondary ureteritis which may be either simple or infective.
   (*a*) Spreading downwards from the kidney.
   (*b*) Spreading upwards from the bladder.
   (*c*) Originating in and communicated from neighbouring tissues and organs, *i.e.* the cellular tissue of the broad ligament, the uterus, ovary or Fallopian tube, or the pelvic lymphatic glands.
   (*d*) Spreading from the mouth of a ureteral fistula.

Etiology.—*Primary ureteritis* is very rare and probably only arises when microbic invasion of the ureter follows an injury, or the lesions wrought by the impaction of a calculus or some other foreign body. In these cases the inflammation is often localised, not extending far beyond the seat of the lesion, although the ureter above the inflamed area as well as the renal pelvis becomes dilated in time by the obstruction caused by the œdema of the inflammatory process and the stenosis which often results from it. But this limitation of the inflammation is by no means invariable; we find in some cases, where a calculus has been impacted in the upper end of the ureter, the whole canal has been inflamed and subsequently been converted into a fibrous cord.

Independently of the invasion of the ureter by pyogenic organism, the walls of the ureter are sometimes found thickened; perhaps as the result of some irritation within the lumen, perhaps of some irritation in the peri-ureteral cellular tissue, just as the fibrous capsule of the kidney is sclerosed as the result of some long-standing irritation within or around it. Hallé thought that in cases of primary pyelitis, it is probable that inflammation of the ureter occurs simultaneously with and is due to the same cause as the pyelitis.

Secondary ureteritis.—Ureteritis commencing at the renal end spreads occasionally from the inflamed fibrous capsule of the kidney, but commonly from suppurative pyelitis, pyelo-nephritis, or pyo-nephrosis, due to some cause originating within the kidney. These lesions of the renal parenchyma, calyces and pelvis arise by the invasion of the kidney by pyogenic organisms after injury, or when it is the seat of calculus, or of obstruction from some cause situated at the infundibulum.

There is not, so far as I am aware, any case proving that ureteritis, apart from injury and the lesions referred to, ever occurs as a simple idiopathic disease. It may do so, but the cases must be rare.

Rousseau quotes two cases as illustrating the fact that ureteritis may exist alone, but in one of them cystitis had occurred and was almost certainly the primary cause; in the other, though neither kidney nor bladder was involved, the pus in the ureter was probably derived from an abscess within the peritoneum which had opened into the ureter.

It is conceivable that by the ascent of microbes from the lower urinary passages, primary ureteritis might occur without the mucous membrane of the bladder taking any part in the inflammation, but such cases are rare; and if they occur the renal pelvis would certainly soon become involved, just as it does when primary ureteritis is set up by para- or peri-ureteritis or genital causes in which the bladder takes no share.

Whilst the frequency of ascending ureteritis is universally recognised, and whilst it is generally admitted that renal disease is a very common result of lesions in the lower urinary organs resulting in what is misleadingly called surgical kidney, it is not sufficiently recognised that the bladder is sometimes invaded by secondary ureteritis, secondary that is to renal lesions. I am not now referring to vesical irritability and other functional disturbances due to renal disease, and of which I have previously written, but to organic disease of the bladder, secondary to organic disease in the kidney. The most marked of the secondary descending affections is tuberculous ureteritis, but it is not the only one. I have, not seldom, known of typical attacks of cystitis associated with pain and tenderness along the course of the ureter supervening upon calculus in the kidney, localised abscess presumably of traumatic origin, or in the course of calculous pyo-nephrosis. In several cases of long-standing renal calculus I have been informed of three or four, or more, intercurrent attacks of cystitis, following severe pain and tenderness in the iliac fossa and along the course of the ureter, which have lasted weeks or months, completely prostrating the patients, and which have been recognised and treated as cystitis by able practitioners and surgeons; yet in these cases the earliest symptoms had reference to the kidney, and the removal of a renal calculus, or the excision of a small abscess, has cured the patients, freeing them from further attacks of cystitis, and relieving them of an attack actually existing at the time of the renal operation.

In these cases it has not been possible, from the course and history of the illness, to suppose that the calculus has been what is called of secondary formation, *i.e.* following and due to an ascending septic ureteritis originating in a cystitis which had previously disappeared. On the contrary, I believe the cystitis to have been secondary and due to descending ureteritis of renal origin.

I think occasionally the prostate may be affected, without the bladder being attacked, by septic infection descending from the kidney, as in the following case. A young man, with marked calculous pyelitis, with an abundant discharge of pus in a faintly acid urine, was operated upon by me in 1887 for renal calculus. He had had for nine years previously symptoms of renal calculus, upon which the suppurative pyelitis became engrafted. During the end of his convalescence and about the third week after his operation, with pyuria still continuing, he suddenly developed an acute prostatic abscess after complaining of much pain and great tenderness along the course of the ureter. There was no cystitis, but from the clinical signs it seemed evident that there had been descending ureteritis. The patient was not tuberculous, had never had gonorrhœa, and no instrument had ever been passed into his urethra till the prostatic abscess caused obstruction and retention of urine. Then the catheter was only required once, as the abscess, very superficially situated towards the urethral aspect, was ruptured by its passage on the first occasion. The patient quite recovered from the operation and quickly from the prostatic abscess. But he never lost his pyuria, though he remained in excellent general health, till ten years later, when fresh symptoms set in and I removed his kidney for calculous pyo-nephrosis. In the interval there had been no vesical or prostatic mischief, and after nephrectomy his urine became quite clear, and has remained so ever since.

This case is of great interest as showing the following sequence of events: *first,* a primary renal calculus of uric acid and urates; *next,* suppurative pyelitis and the deposit upon the calculus of a quantity of mixed phosphates; *then,* removal of the calculus from the kidney, and a few weeks later an acute prostatic abscess without any ascertainable cause other than infection from the pus in the urine; *years later* a secondary renal calculus, formed as the result of the suppuration still going on in the renal pelvis and calyces; and *lastly,* the excretion of completely natural urine immediately after nephrectomy.

Clinical experience has convinced me that there are many cases in which the inflammation spreads downwards. In

1884, when writing "Surgical Diseases of the Kidney," I laid stress upon the statement that "not only do hydro-nephrosis, pyo-nephrosis, acute interstitial nephritis and suppurative pyelo-nephritis result from stricture of the urethra, enlarged prostate and the numerous other causes of chronic cystitis and renal obstruction, but *various functional and organic affections of the kidney give rise to functional and organic affections of the bladder.*" Since this was written the whole field of bacteriuria has been opened up, and many researches have shown that though micro-organisms circulating in the blood can be quickly passed off through the kidney without infecting the organ, yet that under certain conditions favourable to their development these organisms remain and multiply and produce their pathogenic effects primarily in the kidney. A number of different micro-organisms have been found in the urine and urinary organs, but the most frequent and most actively destructive is the bacillus coli communis.

Injury, renal calculus, renal retention of urine from pressure, from tumour, or the gravid uterus, have been proved to favour the infection of the kidney by pathogenic organisms circulating in the blood. Hence we see hydro-nephrosis becoming pyo-nephrosis, acute suppurative pyelo-nephritis occurring during pregnancy, and calculus in the pelvis or a calyx of the kidney resulting in suppurative pyelitis or renal abscess, in persons who have never had an instrument introduced into the urethra, never had gonorrhœa or simple urethritis, nor any prostatic or vesical trouble.

It is doubtful what is the relative proportion of cases in which the primary inflammation begins in the kidney on the one hand, or in the lower urinary tract on the other. The statistics from wards and hospitals specially devoted to diseases of the urinary organs show a great preponderance of ascending disease; but these statistics are probably one-sided; many persons in whom microbic infection of the kidney is present go to the wards and hospitals for general diseases, perhaps not even suspecting that they are the subjects of any renal lesion.

Noel Hallé, the author of the very admirable work on "Ureteritis and Pyelitis" (Paris, 1887), from whom nearly all the French authors who have written on the subject since have copied, says in his Introduction: "I have during my year as Interne in the special service of the Necker Hospital, observed clinically and anatomically a certain number of cases of pyelitis. In all these cases the pyelitis was consecutive to a cystitis itself caused by some affection of the urethra or prostate, etc." In this exhaustive treatise Hallé is far from basing his observations and deductions on the cases alone which he had himself under notice; his sources of information are as wide and numerous as his opinions and conclusions are carefully considered and judiciously drawn; but the preponderating influence is not unnaturally directly and indirectly that of the Necker Hospital. What we now want is (1) a knowledge of the clinical condition of the lower parts of the ureter in cases of cystitis which get well; and (2) careful observation of the lower tracts of the ureter in kidney affections of persons who die in general hospitals. I say especially "of the lower tracts of the ureter in kidney affections," because not only is it stated that descending ureteritis is extremely rare, but also that when it occurs it involves a less length of the ureter than the ascending.

There is, too, in many cases great difficulty in making sure of the order in which the different parts of the urinary system are infected. It does not follow, for instance, that pyelitis and ureteritis have necessarily taken their start from the bladder because cystitis exists when the patient comes under our care. It is very certain that ureteritis and cystitis do occur consecutively to lesions of the renal pelvis and of the kidney, and, as I have just stated, I have seen several cases in which intercurrent attacks of cystitis have complicated pyelitis and pyelo-nephritis without having any other assignable cause than extension of ureteritis, or infection from septic material taken down with the urine. Conversely, cystitis may have disappeared by the time a patient comes under us with well-marked pyelitis and yet the renal affection is the consequence of an ascending ureteritis started by the cystitis. I recall a somewhat important case in which a well-known consulting surgeon, forgetful of this fact, cast a most unmerited reproach upon a general practitioner, and upon the young surgeon whom the general practitioner called to his aid, for their treatment of the bladder of a gentleman who had had severe cystitis following gonorrhœa and running on into ascending ureteritis and pyelitis. The pyelitis continued long after the urethral and vesical inflammation had disappeared, and the consultant would not allow himself to be convinced that the bladder had required treatment.

The predisposing causes of ascending ureteritis in the male are phimosis, urethritis, gonorrhœa, gleet, stricture of the urethra, inflammation, chronic hypertrophy and cancer of the prostate. These causes, by so frequently giving rise to cystitis, lead to secondary infection of the ureter through the bladder; but it is not necessary that cystitis should have been first developed. They may act as indirect causes by inducing renal and ureteral retention and so predisposing the renal pelvis and ureter to inflammation without setting up cystitis.

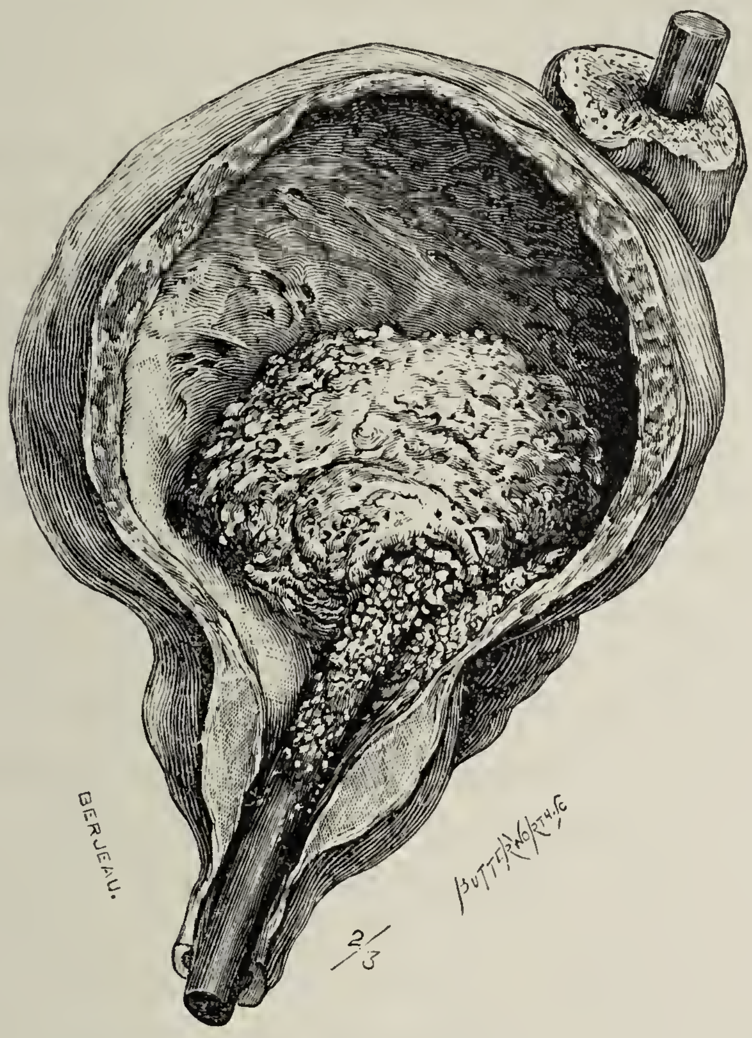

Fig. 155.—Chronic Inflammation and Hypertrophy of the Ureter, due to Villous Papilloma around the Left Ureteral Orifice. (Westminster Hospital Museum, No. 846.)

In both sexes, calculous and other forms of cystitis and growths (Fig. 155) or ulcers in the bladder; retention of urine during fever and other acute diseases; muscular atony or paralysis from spinal and other conditions; and inoculation by dirty catheters or other instruments used on the urethra or bladder, initiate ascending ureteritis.

In the female there are predisposing causes of pelvic and genital origin, such as pressure on the pelvic part of the ureter by the pregnant uterus, or by myomata or epithelioma of the uterus; the various complications of pregnancy, such as inflammation of the uterus or broad ligament, of the cellular tissue, or peritoneum in the pelvis generally; pelvic hæmatocele; and inflammation of the bladder. Other causes are enlargements and inflammation of the ovary and Fallopian tube and pelvic lymphatic glands; vulvitis; and injuries during labour. Finally, uretero-uterine and uretero-vaginal fistulæ, and the abnormal openings of the ureter into the rectum, vagina, or urethra, are conditions favourable to the spread of infection to the ureter, and when they exist are common starting points of ascending ureteritis.

Rayer, and since Rayer, Chamberlain in America, Hallé in France, and Matthews Duncan in our own country, have pointed out this tendency to renal affections of genital origin, especially in puerperal women, caused by inflammation following the course of the ureter. I have given numerous statistics showing the effect of cancer of the uterus and other pelvic causes in producing hydro-nephrosis, pyo-nephrosis and pyelo-nephritis, and Feré and Caron have done the same. More recent experience has taught me that pregnancy may be the starting point of recurrent attacks of uretero-pyelitis without cystitis; and that pyelo-nephritis of a most acute form, attended with rigors and very high fever and considerable renal enlargement, occasionally follows at a short distance after parturition. I have successfully performed nephrectomy in one case for this condition, and have seen death from general septic infection in another. Ascending ureteritis once established may be aggravated by conditions within the ureter itself, such as the stagnation of urine above a valve or stenosis, or by the morbid changes induced by a calculus or other substance which had been impacted in the ureter.

In ascending ureteritis the orifice and the inter-vesical portion of the ureter are not dilated or otherwise changed in every case, but present in this respect a strong contrast to the rest of the tube. Much more commonly, however, the ureteral orifice is much dilated, in the manner and under the physiological and pathological influences to be presently described, either of retention of urine on the one hand or of frequent and violent contractions of the bladder on the other hand.

The damaging effect of simple vesical distension, as well as of painful, frequent, and forcible muscular contractions of the bladder, is a powerful predisposing condition for ureteritis, whether the ureteral orifice yields early or not at all.

In the early stages the evil results from the damming back of the urine in the ureter by pressure on the valvular uretero-vesical orifice. The urine is only admitted to the bladder with difficulty, and not admitted at all during the state of vesical distension. This causes weakening, dilatation, twistings, and valvular folds in the ureter. In the later stage, when the valvular character of the ureteral orifice has been overcome and the ureter throughout the whole or the greater part of its length is greatly stretched, septic organisms from foul urine or an inflamed bladder easily invade the ureter and ascend rapidly to the renal pelvis and parenchyma.

Le Dentu very rightly points out that ureteral dilatation does not necessarily imply antecedent vesical dilatation, because an inflamed and irritable bladder though thickened and contracted may lead to it. He writes: "Painful cystitis, not necessarily retention of urine, leads to moniliform ureters." But I would add, as being equally true, the converse statement, namely, that retention of urine, not necessarily painful cystitis, leads to ureteritis with dilatation, as we see in old prostatic cases, when the urine becomes foul. In these cases the bladder may be over-stretched, having thin walls and large sacculi containing foul urine, but none of the pain of ordinary cystitis.

The causes of peri-ureteritis are the same as those of perinephritis and of ureteritis, from either of which it often emanates.

In parametritis and perimetritis the inflammatory process has a strong preference for spreading along the ureter to the kidney and not rarely gives rise to peri-ureteral and perinephric abscess. They also cause albuminuria and pyuria, which may assume alarming proportions in non-puerperal as well as in puerperal women. These urinary changes, as pointed out by Matthews Duncan,* are not due to vesical but renal conditions: they begin during the para- and peri-metric lesions and subside with them. In parametritis especially, it is well known that the inflammatory process is very prone to follow the course of the ureter.

Pathological anatomy.—1. *Ascending Ureteritis.*—The morbid changes in ureteritis are very various, and depend on the acuteness or chronicity of the inflammation, on the causes, on the extent to which the peri-ureteral tissues share in the inflammation, and especially upon whether the ureter has been dilated and elongated from obstruction before it has been attacked by inflammation.

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* *Roy. Med.-Chir. Trans.*, vol. xlvii., p. 274.

A distinction must be drawn between the mechanical effects of obstruction and the changes strictly due to inflammation. In mechanical dilatation, whether from congenital or acquired causes of obstruction, the ureter becomes elongated and tortuous, doubled upon itself in sigmoid-shaped flexures, wider at one place, narrower at another, but everywhere increased in diameter, with very thin walls in the more dilated parts and thicker sclerosed walls at the flexures, where they have the appearance of being constricted or strictured (*see* Fig. 62, Vol. I., p. 441). The ureter, in fact, as the effect of mechanical obstruction, may undergo all the changes which occur in the walls of a varicose vein; or it may become the seat of chronic simple inflammation, or of an acute infective inflammation; and sometimes adhesions may form between the walls of the tube at points where it is bent upon itself, or between the walls and the surrounding cellular tissue.

When inflammation attacks a tube previously much dilated, and the kidney, or, if bilateral, as these changes so often are, the kidneys are much atrophied, the general state of the patient is unfitted to resist it and the result is rapidly fatal, probably within the course of a few weeks after the onset of the ureteritis. There is a great difference between these ureters and the rigid, thick-walled, indurated tubes, with dense sheaths of inflamed peri-ureteral tissue, which is the condition commonly found when the inflammation has been very chronic and not preceded by dilatation from obstruction.

The dilated ureter, with sub-acute or acute suppurative inflammation affecting the mucous membrane superadded, is the variety which characterises old prostatic cases and cases of traumatic stricture and retention from paralysis or atony, in which the urine becomes septic after a long period of obstruction. In these cases the infection rapidly spreads upwards and soon kills off the patient by suppurative pyelo-nephritis.

The thickened, indurated, rigid and straightened tubes are found in ureteritis of genital origin, and in old stricture cases in which the bladder is merely hypertrophied or has been the seat of long-standing or often-repeated slight cystitis of a non-infective or very slightly infective order.

There are other cases of ureteritis—very much less common, however, than either of these typical forms—in which the two typical pathological conditions are combined: cases in which the inflammation has had time to affect the peri-ureteral tissues around the dilated and sinuous ureter; and others in which there are some slight dilatations, pouches and valves in the thickened indurated tubes, with sheaths formed of condensed fibro-fatty peri-ureteral tissue.

The acute form.—If the process has been sub-acute or acute throughout, the walls will be neither greatly dilated on the one hand, nor greatly thickened and indurated on the other. The mucous membrane is congested, ecchymosed, covered with mucus or muco-pus which may or may not be blood-tinged. All the coats may be swollen and œdematous, and on section the lumen of the tube may remain patulous. In places the mucous surface may be adherent, or its normal plications, stiffened and swollen by the inflammatory exudation, may stand out here and there like valves.

Microscopically the epithelium is lost, and the various coats are infiltrated by a quantity of embryonic cells, and, if the process has not been too rapid, by newly formed vessels.

As above stated, the effects of acute inflammation are often engrafted upon the chronic changes of obstruction. But as in these cases the entire series of changes is of slow formation and long standing, they are more appropriately considered under the chronic form of ureteritis.

The chronic form.—There are two types of chronic changes met with, very distinct from one another, and under one or the other of which can be placed nearly all the cases of ascending ureteritis. Hallé states that the cause of the different nature of these types is the intensity and course of the vesical lesion which leads to them.

In the first group of cases the ureters are dilated, with very distinct valvular strictures, and without very pronounced inflammation of the peri-ureteral tissue.

In the second type the ureters are less dilated, very much thickened, with or without annular fibrous constrictions, and ensheathed by fibro-lipomatous tissue which intimately adheres to them, and which is the result of peri-ureteritis.

The dilated type.—In the dilated type the ureters are often as large as the small intestine, their tortuosity is extreme, and they frequently have a moniliform and spiral appearance not unlike, as Hallé describes them, a large umbilical cord. This condition is especially pronounced at the junction of the ureter with the renal pelvis, and, to a rather less degree, just before the ureter enters the bladder. It is also at these points chiefly that the very limited amount of peri-ureteritis which occurs is found; in the rest of its course the ureter is often quite free and mobile, and easily separable from its connections.

At the points of greatest dilatation, where it may have a diameter of even three or four inches, it gives a feeling of fluctuation; at the points of bending, where it is narrower and of a diameter of from two inches to three-quarters of an inch, or less, there are circumscribed thickenings, which give the sensation of distinct, hard, bridle strictures. On laying open the canal the mucous membrane is seen to be thickened, smooth or flocculent, red in places, especially near the extremities, elsewhere grey, with vascular streaks and dark ecchymotic patches, and ulcers the bases of which are raised up by underlying vessels of large size. At the points of flexure there are veritable strictures, taking the form of bands, folds, and projecting spurs; in some places these are slightly marked and limited to one small part of the circumference; in another, they form projections almost entirely encircling the lumen. The valves are simple duplicatures of the wall of the ureter at the points of bending of the tube, and are maintained by the adhesions on the outside between the apposed surfaces of the ureter at these flexures. In places, several of them succeed one another upon a space of two or three centimetres, and they occupy the greater part of the circumference, being more prominent at their middle part, and gradually fading off at their extremities, reminding one, as Hallé says, of the valvulæ conniventes, which they somewhat resemble. Between these projecting folds are well-marked saccular dilatations, which communicate with each other only by a narrow tortuous channel, twisted in its course like the worm of a screw. These valvular formations occur chiefly at the two ends of the ureter, making the middle part of the canal appear like an elongated, fusiform, and more or less straight sac, which contrasts strongly with the twisted sinuous extremities; but they often occur also at a distance of two and a half to three and a half inches from the bladder, just below the level of the inlet of the pelvis. The reason for the valves being so constantly near the two extremities of the ureter is probably twofold: It is at these points that there are (1) natural narrowings in the duct; and (2) the movements of the kidney, and the distension and contractions of the bladder respectively, which tend to cause flexions and movements in the adjoining parts of the ureter. These valve-like processes materially diminish the lumen of the canal and, in spite of its great distension, cause considerable obstruction to the passage of urine. These valves, and the sharp turns made by the elongated ureter, so alter and divert the course of the channel that there is often great difficulty in finding the passage from the ureter into the renal pelvis, and also along the last inch or two above the bladder. Indeed, the abdominal portion of the ureter in some instances forms a sac much larger than the renal pelvis, and separated from it by a narrower sigmoid canal, with prominent valves within it, and along which it may be almost impossible to pass even a flexible bougie.

Microscopical characters of the valves.—The microscopical characters of the valves have been thoroughly examined and carefully described by Hallé. Briefly, they are composed of newly formed muscular tissue. In a longitudinal section of the ureter passing through one of these valves the longitudinal fibres of the ureteral wall are seen following their natural direction above and below the valve; but at the level of the valve the muscular fibres penetrate it and become changed in appearance. Here the fibres are very numerous, small, and separated; their direction is varied: some run longitudinally or obliquely at the base of the valve, but towards the free edge there are numerous transverse bundles forming an imperfect muscular sphincter. These consist partly of the normal muscular tissue, altered in direction, but chiefly of hypertrophied and newly developed bundles. The mucous membrane has entirely lost its epithelium, and it is thickened and composed of a layer of round cells, pressed closely against each other; being, in fact, embryonic inflammatory tissue with numerous newly formed vessels in its substance.

Hallé describes some small projecting cysts as being frequent in the mucous membrane of the more chronically inflamed ureters. Cruvelhier, Rayer, and Lancereaux, under the name of vegetating or cystic ureteritis, had also previously noticed them. These are minute thin-walled sacs in the epithelial lining, containing a mass of cells in a state of granular degeneration.

Fibrous type.—In the second type the most pronounced feature is the intensity of the associated peri-ureteritis. The ureter is surrounded throughout its course by a thick and indurated casing of fibrous or fibro-fatty tissue, which ensheathes and hides it, and is intimately adherent to it, so that it is often far easier to dissect out this sheath with the ureter than the ureter from within the sheath. In other cases it is fairly free from adhesions, and can be easily removed by a few touches with a scalpel. The ureter itself is thickened, shortened, straightened, and fixed. The mucous membrane shows similar changes to those of the other type. It is greyish, or slate-coloured, or bluish-black, and smeared with muco-pus or sanguinolent pus; and desquamation, abrasion, and ulceration are going on; but it is thicker and tougher—in fact, all the coats are thickened, and tend towards conversion into fibrous tissue. They are tough and rigid, and present at intervals slight enlargements, with walls sometimes of quite cartilaginous consistence. This thickening of the walls of the ureter, together with the inflammation of the peri-ureteral tissue, gives the ureter the feeling and appearance of considerable size, and a resistance which often enables it to be felt through the abdominal walls or *per vaginam*. There is only a slight degree of dilatation, and on section the ureter barely exceeds the diameter of the little finger. Strictures are frequent, but are altogether different from the valvular strictures above described as occurring in the dilated tubes. They are annular fibrous strictures, like the cicatricial strictures found in the urethra and other musculo-mucous canals. In some cases they take the simple ring form; in others they form indurated cylinders extending over a considerable length of the duct; whilst in others the lumen of the canal is almost obliterated by this sclerotic change nearly or entirely throughout its whole length. In the most extreme degree these stricture formations may result in the complete obliteration of the ureter. They occur at any part of the ureter indiscriminately, and frequently affect one ureter only—marked distinctions these from the valvular folds in the dilated ureters, which occur specially at the extremities of the canal and in the ureter of each side to almost the same degree.

It is in this second group that we meet with large unilateral pyo-nephrotic tumours, whilst the opposite kidney is quite or relatively healthy, and equal to the requirements of the body. It is also in this group of cases that we find large phosphatic calculi in the renal pelvis and calyces, as secondary formations, due to the fermentative changes in the urine, induced by the suppurative pyelitis.

Microscopical characters.—The microscopical characters of these strictures differ entirely from those of the valvular formations in the dilated ureters. Hallé describes them as having no duplicature of the wall, no hypertrophy of the muscular tissue, but as consisting of fibrous and newly formed connective tissue, with very little muscular tissue, less even than in the rest of the ureteral wall. There is the same proliferation of embryonic cells and development of new blood-vessels in the wall of the ureter as in the other form of chronic ureteritis.

The condition of the uretero-vesical orifice.—The condition of the uretero-vesical orifice is a matter of great interest and some importance in ureteritis. It is often dilated, but it is not invariably so. Hallé says that in most of the cases of ascending ureteritis these orifices have their natural appearance and normal calibre, admitting only a strong stylet as in their natural condition. Often they are only indicated by a slate-coloured spot more marked than the surrounding mucous membrane. In these cases, which are the most frequent, the interparietal part of the ureter also is healthy, its mucous membrane pale, and its valvular arrangement perfect. This condition, contrasting strongly with the dilatation of the ureter above, creates at the level of the entrance of the duct into the wall of the bladder a veritable stricture which is very striking when the ureter is incised and laid open to its mouth. In rare cases the extremity of the ureter projects, or even bulges into the cavity of the bladder. In other cases the orifice takes part in the enlargement of the rest of the ureter; it is widely open, admitting the beak of a sound, has lost its valve-like arrangement, and forms a large and direct communication between the bladder and the ureter. When thus dilated the ureter occasionally, but rarely, opens at the bottom of a depression in which the mouth of the duct is almost hidden. Hallé remarks that though this arrangement of the ureteral orifice is rare, he has many times observed that this is a favourite place for the development of an ordinary vesical sacculus, and such a sacculus acts as a cause of obstruction to the passage of urine down the ureter. Chopart cites an observation of Palletan where the sound introduced to explore the bladder entered the dilated ureter.

Mechanism of the changes in the uretero-vesical orifice.—The physiological action of the uretero-vesical opening becomes enfeebled and lost, and the orifice becomes patulous under the influence either of cystitis without retention or of retention without cystitis. These changes in the ureter are brought about by the alterations in the walls of the bladder, but these alterations in the bladder are not the same in the two classes of cases. In *retention without cystitis* the ureteral orifices are closed by pressure when the bladder is full; meanwhile urine is accumulating in the ureters, and this accumulation serves to distend and weaken the ureteral walls just as the vesical retention enfeebles and stretches the walls of the bladder.

In the distension of the muscular coat of the bladder the prolongations of the muscular wall of the ureter participate; these two bundles of muscular fibres—one going forward towards the prostate and urethral orifice, and the other inwards to join the corresponding fibres of the opposite ureter—are elongated and weakened, and lose their contractile power, and, in consequence, the obliquity and sphincter-like action of the ureteral mouth are lost. Mechanical dilatation of the ureter is then aggravated by the reflux of urine; and also, as soon as inflammation occurs, by the obstruction caused by the inflamed walls and the diminished resistance to stretching which they offer when inflamed.

Moreover, acting together with this loss of muscular tone is the downward pressure effect of the column of urine accumulated in the ureter above. It is by this weakening and overstretching of the vesical walls and this downward pressure of the dammed-back urine in the intermural part of the ureter that the sacculus is formed into which Hallé describes the ureter as occasionally opening.

In *cystitis* the loss of function of the ureteral opening results from the muscular fibres of the bladder and lower end of the ureter becoming *contractured* * by the frequent, and often spasmodic, contractions of the bladder during the incessant and painful acts of micturition, and by the inflammatory exudation, which thickens and stiffens all the tissues of the bladder walls. This contractured state of the fibres shortens the part of the ureter passing within the substance of the vesical wall and tends to pull the ureteral orifice into the bladder, and at the same time to pull it open, and as the course of the ureter is between the mucous membrane and the muscular coat of the bladder, the shortening of the bladder fibres tends to approximate the ureteral orifices to one another and to the urethral orifice.

When once the integrity of the valve-like connection between ureter and bladder is lost, the gate is open to the spread of infection to the ureter and kidney, and the ureteritis which may have previously existed becomes aggravated.

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* I employ this term to indicate a persistent shortening caused by frequent repetition of contractions.

2. *Ureteritis secondary to renal disease.*—When the ureter is inflamed secondarily to the kidney, *i.e.*, in descending ureteritis, the pathological changes vary with the nature of the renal lesion. If the kidney, long irritated by a calculus, for example, is in a state of chronic interstitial nephritis, with a thickened capsule and a quantity of fibro-lipomatous perinephric tissue around it, the walls of the upper part of the ureter will be thickened and tending to fibrous changes, the mucous membrane will be congested, and the peri-ureteral tissue will show the same fibro-lipomatous changes as the perinephric tissue, along more or less of its course.

If the chief renal lesion is pyelitis, then the mucous membrane of the ureter will be congested, or of a mottled grey and red colour, and will be coated with pus or purulent urine, and show signs of ulceration. Its wall will be œdematous, and on section the lumen will be seen diminished at the level of the ulcers.

In one case, in which the kidney was small and had undergone fibro-lipomatous transformation to a great degree, the ureter was carefully examined and was found in the following condition: Its central part was dilated over a considerable length to the size of the little finger; it gradually tapered off towards its extremities. Towards the bladder end its walls presented nothing abnormal, but towards the kidney they were more than double their normal thickness, and the mucous membrane was exceedingly congested. The mucous and sub-mucous tissues were inflamed and congested. Throughout the dilated portions the walls were very thin, and consisted merely of bands of fibrous tissue, surrounding a very thin layer of inflamed mucous membrane. On microscopical examination there was general infiltration of the walls, with embryonic tissue most marked above and very slightly in the vesical end. The epithelium had everywhere disappeared.

Peri-ureteritis.—When the peri-ureteral connective tissue is involved it is dense, tough, with, very often, firm masses of fibro-lipomatous material such as are so often found in old cases of chronic perinephritis. This sclerosed tissue sometimes envelopes the ureter like a very thickened sheath, which on being incised can be laid open and the ureter turned out, much like a banana from its skin. In other cases the sclerosed tissue is much more adherent to the ureter and compresses it, diminishing it pretty uniformly throughout, or producing at places regular fibrous constrictions.

These changes in the peri-ureteral tissue, combined with the thickened state of the coats of the ureter, give the tube the false appearance of enormous size, and so firm a consistence that it is often not difficult to distinguish it on palpation through the abdominal walls or *per vaginam.*

In rare cases, diffused suppuration or abscesses form in the peri-ureteral tissue; these are seldom or never due to leakage or extravasation, because the proper walls of the ureter are supported and protected against perforation by ulceration, by the tough inflamed sheath which invests it. These fibro-lipomatous changes in the connective tissue about the ureter are often extended into that which surrounds the kidney, and spread into the hilum and between the calyces, producing even a fibro-lipomatous transformation of the kidney itself.

With the various pathological changes of ascending ureteritis which have been described above are associated the renal changes due to obstruction and inflammation. As these have been dealt with at length in Part I. of this work it is unnecessary to recapitulate what has been said under the headings of suppurative pyelo-nephritis, hydro- and pyo-nephrosis, and chronic interstitial nephritis.

Diagnosis and symptoms.—We know nothing about the symptoms of acute or chronic ureteritis as an idiopathic disease, if there is such a thing. It is not probable that ureteritis could exist without being immediately or very rapidly the cause of symptoms referred to, and due to changes in, the kidney either from obstruction caused by the inflamed ureter or from pyelitis as an extension of the ureteritis.

We can imagine a case in which the bladder is proved to be, and to have previously been, quite healthy, in which the kidney is not enlarged or tender to pressure or is even found healthy by an exploratory operation, but in which there are tenderness and pain, and a cord-like thickening along the course of the ureter to be felt through the abdominal walls and on vaginal or rectal palpation, and in which pus in faintly acid or neutral urine is present. With such negative and positive symptoms, it would be impossible to make any diagnosis but that of ureteritis; and with these symptoms, in the absence of injury, or of calculus, or other foreign body impacted in the ureter, we should be obliged to conclude that we were in the presence of a case of idiopathic ureteritis.

In all other cases the symptoms of ureteritis are mixed up with those of the affection of the bladder or kidney, to which the ascending or descending inflammation respectively is secondary, and at a later stage there would be in addition the symptoms of the renal lesions by which inflammation of the ureter is soon followed when it commences below. Sometimes, therefore, the predominant symptoms will be those of cystitis, in others those of pyelitis. The ureteritis begins and advances so insidiously that it is rare to be able to diagnose, with our present knowledge, cystitis alone from cystitis complicated with ureteritis, or pyelitis alone from uretero-pyelitis, though it is not generally difficult to know when the ascending inflammation has reached the renal pelvis, and still less so when suppurative pyelo-nephritis has once commenced (*see* Vol. I., p. 320 *et seq.*).

If the starting point of the inflammation is parametritis or perimetritis, or an infection through a uretero-uterine or uretero-vaginal fistula, or if the inflammation is provoked by some morbid state of the uterus or its appendages, there is a brief period before the kidney is affected, during which there are albumen and pus in the urine with the absence of any bladder disease, but with tenderness along the course of the ureter on palpating through the vagina or abdominal parietes; there will also be in this interval pain or constant aching in the iliac fossa radiating in the course of the ureter downwards towards the groin, hypogastrium, and inner side of the thigh, and upwards to the loin; and the ureteral catheter will detect a difference between the urine in the two ureters.

An accumulation of pus in a localised dilatation of the pelvic part of the ureter may be taken for a distended tube or a diseased ovary. In one case (Condamin's) such a mistake was made and the swelling was punctured on the supposition that it was an abscess of the Fallopian tube (pyo-salpinx): a urinary fistula followed. The means of diagnosis between a ureteral swelling and a swelling due to the uterine appendages are described on p. 459 of this volume in the chapter on Ureteral Calculus.

In such a case the ureteritis begins as insidiously as pyelitis, and as insidiously as it is superadded to pre-existing cystitis or pyelitis.

When secondary to disease of the bladder or kidney, the onset and progress of ureteritis may be inferred if there is an accession of pus in the urine, with pain on the brim of the pelvis radiating upwards and downwards in the track of the ureter, together with tenderness on pressure over the ureter. Its establishment will be clear if with the above symptoms the end of the ureter can be distinguished and felt to be thickened on palpation. Sometimes when peri-ureteritis is present the ureter is felt like a cord as large as the index or little finger, and sometimes there are nodules felt here and there in its course.

The characters of the urine.—The urine is purulent, whitish in colour, uniformly turbid, and of a stale odour; after standing, and when the bulk of the pus is deposited, the fluid still contains pus and has an opalescent appearance. It is very slightly acid, neutral or alkaline, and readily becomes ammoniacal and offensive. The pus in the urine may be intermittent and the urine at times be quite clear. The strictures in the ureters cause considerable embarrassment to the descent of the urine and pus from the renal pelvis and upper regions of the ureter, and are the causes of the occasional intermittent crises of retention which are attended with so much severe pain and general disturbance of the health, and are accompanied by increase in size of the renal tumour. It is very easy for temporary complete obstruction to occur in tubes so contorted and strictured as the ureters are in the dilated type of ureteritis. A little congestive swelling of the mucous membrane or a little mass of viscid muco-pus is quite sufficient to determine retention in the parts above. Sometimes a simple movement or change of position, by intensifying a sharp curve or provoking a kink, is quite enough to produce the effect. It is in this way that the intermissions of pus in the urine are brought about; and that at times quite clear urine is voided for some days together, owing to the ureter of the suppurating side becoming blocked. The quantity of pus secreted in some of these cases is very great indeed, but not more than would be expected considering the enormous surface of mucous membrane in these dilated tubes. Microscopically the urine shows epithelial cells of the ureter and renal pelvis as well as pus and blood corpuscles and numerous micro-organisms.

Polyuria is frequent in uretero-pyelitis, but is more significant of pyelitis than of ureteritis. Probably it does not exist when ureteritis without pyelitis occurs. It is often preceded by scanty, turbid, and stained urine. The reflex polyuria of vesical origin is less abundant and less constant; and the urine contains very little pus, which is derived from the bladder and is much less intimately mixed with the urine.

In ureteritis there is nothing characteristic in the urine, which is, in fact, undistinguishable from the urine in pyelitis (*see* Vol. I., p. 330).

Pain.—The pain may be so slight as to be scarcely noticed or it may be referred to the kidney or bladder rather than to the iliac region and the brim of the pelvis. In numerous cases of ureteritis no tenderness is discovered on pelvic or abdominal palpation. The ureter is not likely to be felt except in cases where there is marked sclerosis of its own walls or its surrounding cellular tissue has been chronically inflamed. Frequency of micturition, with or without acute pains in the bladder, or attacks of renal colic, or both, is sometimes the chief symptom.

When ureteritis causes attacks of colic, and gives rise to more or less blood or pus in the urine, if movements should aggravate the symptoms, renal calculus is almost sure to be diagnosed. In a notable case of Israel's the kidney was twice explored for stone, yet a small hydro-nephrosis with very aggravated ureteritis, but no stone, was at length ascertained to be present.

Ascending ureteritis should always be suspected in a patient suffering from an old chronic affection of the bladder or prostate, or urethra, when pyuria commences or is increased, and if pain and tenderness are felt along the ureter associated with marked impairment of the general health.

The general symptoms.—The general symptoms are loss of appetite, feeling of chilliness, perhaps slight rigors, possibly vomiting, and diarrhœa. The tongue is red, dry, and often cracked. The temperature chart of ureteritis is the same as in pyelitis and pyelo-nephritis, and the digestive troubles and the loss of flesh are more due to the co-existing renal disease than to ureteritis.

Diagnosis and symptoms of ureteritis persisting after nephrectomy.—We have stated already, more than once, that ureteritis very rarely, at any rate for more than a brief period at its outset, exists alone; that if it does not commence in pyelitis it soon extends to and involves the kidney by its infective nature or its obstructive effects.

There is, however, a very important and difficult group of cases in which ureteritis, though once but a part of a general uretero-pyelo-nephritis, or pyelitis, comes to exist alone; that is when it persists after nephrectomy. We often see, after the kidney has been removed, that pus continues in the urine for a variable length of time, often for an indefinite time. If the pyuria is unattended by pain, as commonly it is, and there is no fistula, the case is left to clear itself up under proper medicinal and dietetic treatment, and it very generally does so. But if a lumbar fistula as well as a continuance of pus in the urine follows the removal of the kidney, we are called upon to decide whether the discharge of pus from the fistula and the pus in the urine are due to a common cause, namely, disease of the ureter; or whether the pus from the loin is derived from an abscess pouch or a loculated sinus in the retro-peritoneal tissues, and the purulent urine from disease in the remaining kidney.

If, as occasionally happens in calculous cases, there is, in addition to the above symptoms, pain complained of, and referred to the opposite kidney, a correct diagnosis is urgently needed, and is most important; for clearly if there be a stone disorganising the only remaining kidney its early removal is imperative.

In diagnosing between a fistula due to ureteritis and one due to suppuration in the cellular tissue of the loin, something may be made out by careful probing, by the injection of coloured fluid into the fistula, by the methylene blue test, by palpation along the course of the ureter, and by a cystoscopic examination. If the probe takes the course of the ureter, if an injection into the fistula of fuchsin in water is quickly followed by the appearance of the coloured solution in the bladder, if a subcutaneous injection of methylene blue is rapidly excreted in the urine, if there is pain or tenderness on palpating in the line of the suspected ureter, and if pus comes from the ureter on the side from which the kidney was removed and clear urine from the other ureter, the cause of the loin fistula is ascertained and the proper treatment—ureterectomy—is indicated.

When there is no pus entering the bladder, the diagnosis as to persisting ureteritis being the cause of the lumbar fistula is more difficult. The lumbar sinus should be laid freely open and tracked to its extremity. It is very possible in doing this that the ureter, if the cause of the fistula, may be exposed and its condition seen; if not, free evacuation and scraping of the abscess cavity and sinus, and free drainage, should be tried; and if a cure does not follow, ureteritis must be suspected and a further operation, namely, ureterectomy, proposed.

Prognosis.—This depends upon the cause and also upon the character of the renal lesions to which it gives rise. When occurring in the early months of pregnancy it often ceases as the gravid uterus rises higher out of the pelvis; when excited by parametritis, perimetritis, or cystitis, it often ceases with the cure of these complaints. If the cause persists, so also in great probability does the ureteritis; thus in cases of intractable cystitis, pyelitis or pyelo-nephritis, the ureteritis continues as long as, often longer than the primary disease. It is more likely to get well when only part of the tube is inflamed, and the exciting cause (*e.g.* pyo-nephrosis, renal calculus, renal abscess) can be removed by nephrotomy, or partial or complete nephrectomy; or by the cure of the primary cause, whether this be situated in the genital or lower urinary organs, the urethra, prostate, or bladder.

There is a greater disposition to recover if the ureter has not been over-distended before becoming inflamed, if the inflammation does not reach the renal pelvis, or if the latter is not dilated as well as inflamed. If the ureteritis is bilateral, as it usually is in the dilated type, the prognosis is very grave. If the kidneys are affected by chronic interstitial nephritis only, the progress is very slow, and leads to pyo-nephrosis; if by parenchymatous inflammation, especially if this is of an acute septic form, the course is very rapidly towards death. The time taken for a pyo-nephrotic enlargement to form varies very much, but it may be years before surgical intervention is sought.

Old ureteritis is not ordinarily cured, especially if the mucous membrane secretes much pus, if the walls are greatly indurated or undergoing calcareous degeneration, or the peri-ureteral tissue is much sclerosed; but the affection may last years, leaving the patient in a condition compatible with fair ordinary existence; and in exceptional cases a complete cessation of all symptoms may be brought about by the transformation of part or the whole of the ureter into a fibrous cord, and of the kidney, if it has not previously been removed, into a small fibrous mass.

When ureteritis becomes chronic the tendency is for the inflammation to spread to the kidney, if it did not commence there, or to cause the kidney to become atrophied and to undergo interstitial nephritis, and to kill the patient by suppurative pyelo-nephritis, *i.e.* ordinary so-called surgical kidney. Still it should not be forgotten that, though lasting a long time, it may improve and even get quite well.

Treatment.—The treatment of ureteritis is for the most part preventive and indirect. Preventive treatment is of the first importance; and consists in taking steps to avoid all causes of cystitis, and of the too frequent, irregular, and too forcible contractions as well as of over-distension of the bladder; to observe the greatest care as to the asepticity of catheters and instruments, and in prostatic cases to insist upon the timely commencement of catheter life; to attend to the regular action of the bowels, the regular emptying of the bladder, and the strict cleanliness of the external genitals, and the vaginæ of women pregnant or the subjects of ureteral or vesical fistulæ; and by the early and appropriate treatment of renal and circumrenal lesions. If cystitis is established, intra-vesical treatment is important to alleviate pain, calm the irregular and excited function, and prevent the infection of the ureter with the micro-organisms in the bladder. Cystotomy, to relieve the incessant contractions of the bladder or repeated retention, may be indicated. Renal calculi should be removed early; renal abscess, whether tuberculous or not, should be opened or excised when small; pyo-nephrosis should be submitted to nephrotomy, or nephrectomy, without undue delay; and pyelitis and pyelo-nephritis treated by milk diet, mineral waters, the waters of Contréxéville, Vittel, or Evian, etc., by salol, biborate of soda, cystamine, and other antiseptic drugs, in doses of five grains to ten grains three times daily, if the stomach will tolerate them, which, unfortunately, in many patients it fails after a time to do.

The direct treatment of ureteritis consists in catheterisation and irrigation of the ureter through the ureteral catheter and the catheter *en demeure* in the ureter; retro-peritoneal ureterotomy in certain rare cases; and ureterectomy. With regard to catheterisation and irrigation of the ureter as a means of treatment, I have previously expressed my opinion as strongly unfavourable to it, and have quoted the views of other surgeons on the subject (*see* p. 328, Vol. II.).

Local treatment of the ureter.—Nathan Bozeman, after treating a case of pyelitis, supervening on an extensive urinary fistula, which involved the bladder, both ureters and the uterus, with success by means of irrigation of the pelvis of the kidney with antiseptic solutions injected through the ureteral orifices,* conceived the idea in another case of chronic pyelitis of creating a vesico-vaginal fistula for the purpose of rendering the ureter more easily accessible, and then daily washing out the renal pelvis. This he did by an operation he called *kolpo-uretero-cystotomy.*

Bozeman's operation is really a simple kolpo-cystotomy; but, instead of being made along the middle line, it is made at the side, starting immediately in front of the angle of Pawlik, corresponding to the ureteral orifice, and so as to divide that orifice.

Bozeman employed ureteral irrigation for chronic ureteritis, and it has since been employed through Nitze's, Casper's, and Albarran's ureter-cystoscope without preliminary establishment of a fistula; and also through Kelly's tubes and Grünfeld's tubes and ureter-cystoscope.

Tuffier suggests that perhaps the cystotomy by which Bozeman preceded his ureteral catheterisation plays the most important *rôle* by putting the bladder at rest, and this might be so if employed in certain cases of the ascending variety of ureteritis; but the criticism does not apply to cases of pyelitis and pyonephrosis of strictly renal origin, and in which the disease of the ureter commences above—unless frequent painful micturition is a leading symptom. Cystotomy might well be resorted to in certain cases as a preventive means, or in the early stage of ascending ureteritis before the renal pelvis is invaded; but there are many objections to ureteral catheterisation, even if it can be borne; they are referred to at length in another place (Chapter III., Vol. II.).

An important means of direct treatment of ureteritis is the inspection and sounding of the ureter at the time of operations on the kidney and ureter, and the removal of a considerable portion of the ureter in all cases of nephrectomy if the tube is inflamed, thickened, or suppurating. As described in the chapter on Ureterectomy, it is quite easy and safe, without extending the lumbar excision very much, to free the ureter, ligature it, and divide it at a point considerably above the brim of the pelvis. In the operation of nephrotomy the upper portion of the ureter should be examined, and if it be found affected it should be first traversed by a catheter to the bladder, and then irrigated throughout with some antiseptic solution. For this purpose an independent incision should be made in the renal pelvis, if the catheter will not readily pass into the ureter from the incision through the renal parenchyma. If this be done, the ureter, though much inflamed and its lumen much encroached upon by the inflammatory exudation, will sometimes undergo great improvement or complete cure after nephrotomy.

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* *Amer. Journ. Med. Sci.*, 1888, vol. i., p. 255.

In uretero-pyelitis, nephrotomy and the irrigation of the ureter from the renal pelvis is, in Guyon's opinion, the method of choice, although suppuration persisted in 57 per cent. of cases thus treated.

It has been proposed in certain cases of ureteritis in which the bladder is free from inflammation, and ureteral catheterisation fails, to cut down along the lumbo-ilio-inguinal line, and if the kidney is found to be unaffected, to perform ureterotresis by dividing the ureter where it crosses the pelvic brim, and suturing the cut edges to the skin for the purpose of daily irrigation and drainage; then, when recovery has taken place, to close the ureteral aperture. If, in the absence of bladder affection, it is either known from a previous lumbar exploration, or confidently inferred from the origin, course, and physical symptoms, that the kidney is not involved, the same treatment, it has been suggested, should be carried out through an incision limited to the iliac portion of this line; or, still better, by the retroperitoneal method, through the incision suggested by Tuffier for extraction of a calculus from the middle part of the ureter, namely, an incision, three fingers' breadth, outside the border of the rectus abdominis and parallel with it.

It has also been suggested to simply puncture a suppurating pouch in the ureter low down in the male through the rectum; and it is stated that puncturing across the peritoneum after laparotomy has in one case been followed by improvement in a woman, though the permanent result is not stated.* But a single simple puncture can rarely be sufficient; and besides, these operations, from the infrequency with which the ureter alone is involved, can only be very rarely applicable. The intraperitoneal method ought to be absolutely condemned, for, besides the probability that the ureter cannot be exposed owing to some of the abdominal viscera being firmly adherent to the peritoneum in front of it, the intra-peritoneal route is dangerous from the risk of infecting the peritoneum by the escape of pus either at the time of puncture or subsequently. In one case (Condamin's) in which the swelling was punctured through the vagina, on a wrong diagnosis that it was a suppurating Fallopian tube, a uretero-vaginal fistula followed, and nephrectomy had subsequently to be performed.

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* Mayo Robson, *Brit. Med. Journ.*, October, 1888.

In women, in cases of suppurative pelvic ureteritis, when ureteral catheterisation has failed, it has been advised to follow Bozeman's operation of colpo-uretero-cystotomy, which affords the opportunity of irrigation and direct drainage of the bladder as well as of the ureter.

The proposal to wash out the ureter and renal pelvis by distending the bladder with tepid water, and keeping up the pressure by the evacuator employed in litholapaxy, is only mentioned here to be condemned as a method of treating uretero-pyelitis. Apart from the remote possibility of rupturing a diseased bladder, or the less remote one of rupturing the thin wall of a sacculus, it is a plan that is physiologically impossible unless the uretero-vesical orifice has been rendered permanently patulous by bladder disease, the very condition under which the pain and the risks of the proceeding would be the greatest, but a condition which in a large number of cases does not exist. In all cases in which the kidney and renal pelvis are converted into a mere pyonephrotic sac, and the ureter is inflamed, thickened, and dilated, nephro-ureterectomy should be performed, to avoid the continuance of ureteral pain and suppuration and the formation of a lumbar fistula. As much of the ureter should be excised with the kidney as is requisite to enable a ligature to be placed upon the duct below the dilated part. A very common situation of stenosis of the ureter in ureteritis is just below the brim of the pelvis at a distance of from three to three and a half inches from the bladder; and if through the lumbo-ilio-inguinal incision the ureter is removed as low as this and ligatured, there are but few cases in which complete cure will not follow, and the lower end of the duct be converted into a fibrous cord.

In a lesson-teaching case of Israel* (referred to at some length in my "Hunterian Lectures," pp. 47 and 48) ureteritis affecting the whole of the duct, including its vesical orifice, but the cause of which is not stated, was cured by the removal of a small soft kidney.

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* *Berlin. klin. Woch.*, No. 27, 1893.

CHAPTER VIII.

TUBERCULOUS DISEASE OF THE URETER.

THERE is evidence to show that tuberculous disease of the ureter sometimes commences in the ureter itself; but as met with in the operating theatre and in the post-mortem room it is always associated with tuberculous disease of the kidney or of the bladder, and frequently of both. Fischer states that the ureter may be the primary seat, and that the lesions afterwards extend from it to the kidney and bladder.

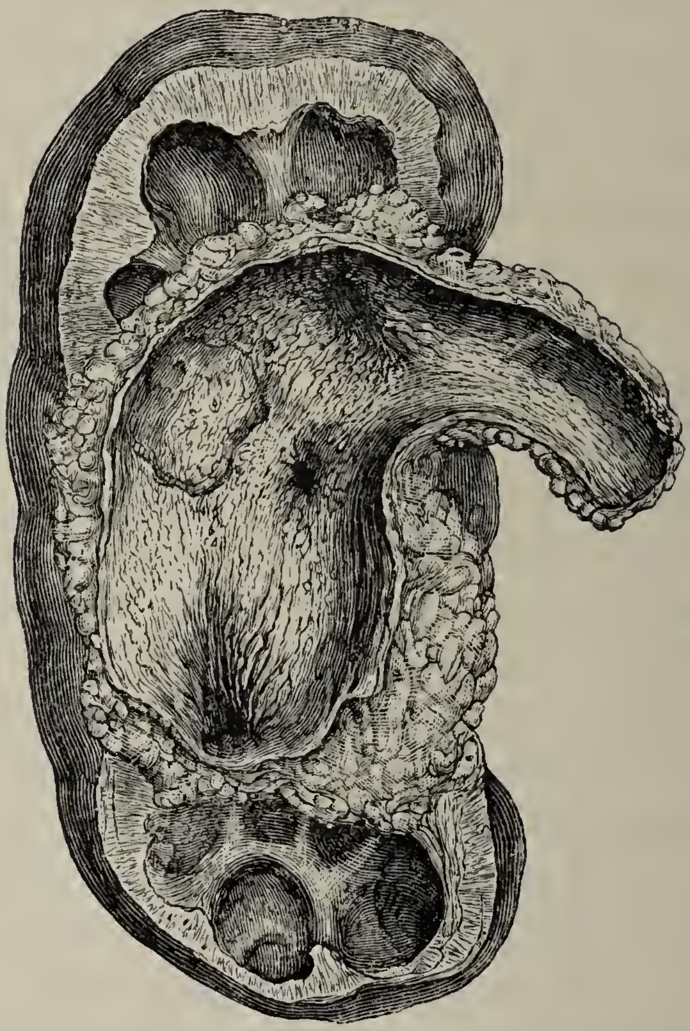

Fig. 156.—Section of a Kidney showing Tuberculous Pyo-nephrosis, with rigid, thickened and dilated upper end of Ureter, and condensed and adherent perinephric tissue.

Pathology.—The disease, in whatever tissue it begins, ultimately affects all the coats of the ureter, thickening and stiffening them, and making them rough on the outer and inner surfaces, and causing them to encroach on the lumen; or the lumen may not be diminished, but may even be enlarged (Figs. 156 and 157). In some cases the walls undergo calcification (Fig. 158). The valvular folds and fibrous annular or cylindrical strictures met with in the other varieties of ureteritis are not formed in tuberculous disease.

On the mucous membrane are disseminated little granular elevations and little masses of tuberculous deposit, in all stages, from minute miliary tubercles to well-marked breaking-down cheesy deposits and open ulcers. Sometimes the whole lumen is stuffed with cheesy material, and the ureter from end to end is thus obliterated, as in Fig. 158; but at the same time the tube may be increased in diameter, and is thus very different from the contracted fibrous slender cord which is found when obliteration has followed simple inflammation and suppuration.

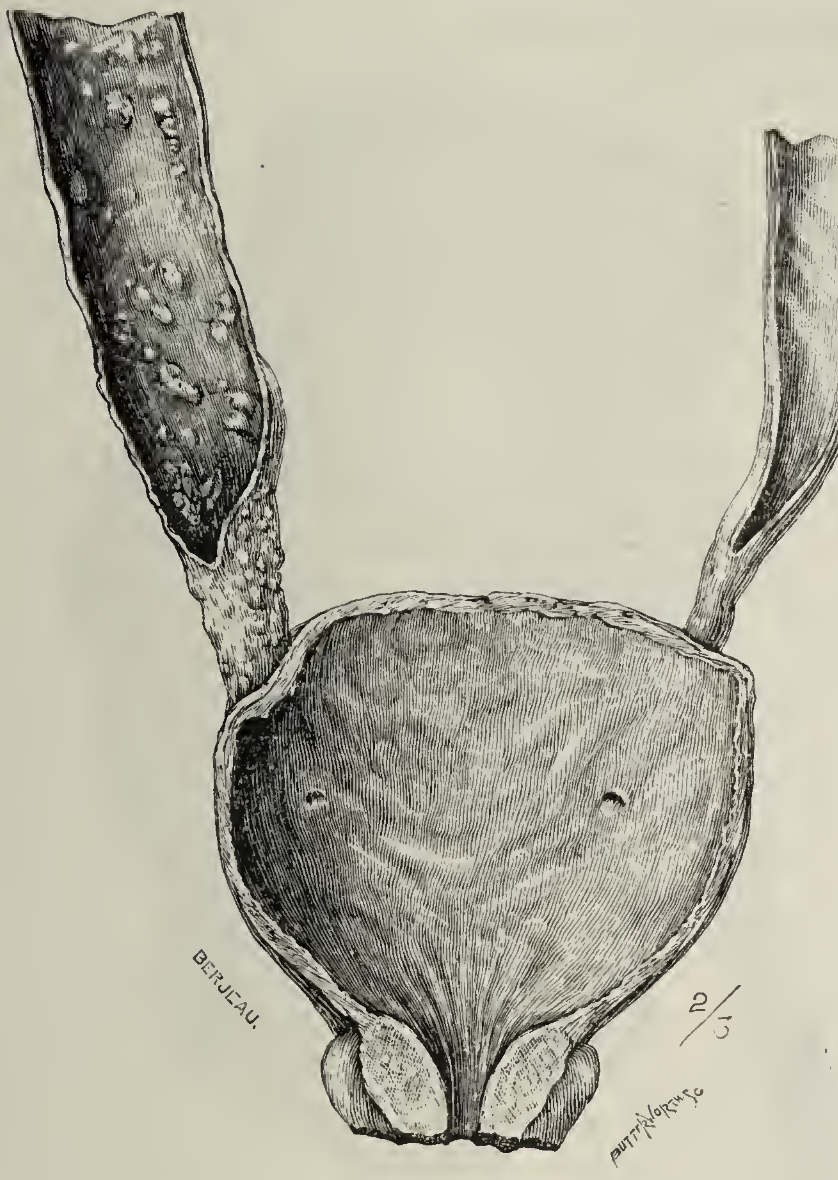

Fig. 157.—Tubercular Disease of lower end of Ureter. (Guy's Hospital Museum, No. 1639.)

A very common appearance of advanced tuberculosis of the ureter is shown in the diagrams of the kidneys and portions of ureters removed during life which illustrated a paper I published in the *Lancet* (January 1, 1898). In some cases the ureter throughout its length is transformed into a rigid cylinder, smooth or bossy on its surface, but so stiffened by the infiltration with tuberculous material that it can be raised and held out straight by taking one end between the finger and thumb. This was the case with the ureter shown in Fig. 201 (*post*, p. 629), which I removed by primary complete ureterectomy.

In many cases the tuberculous tube is surrounded by a very thick layer of condensed cellular tissue. In some of the cases upon which I have operated it has given the impression of a dense thick-walled sheath. Sometimes a tuberculous abscess forms in the cellular tissue, secondary to tuberculous ureteritis; and Tuffier mentions a case of tuberculous disease of the vertebræ provoking an abscess in the tissue adjoining the ureter, from which the ureter itself became infected, and an ascending ureteritis was set up which completely obliterated the lumen of the duct and spread to the kidney.

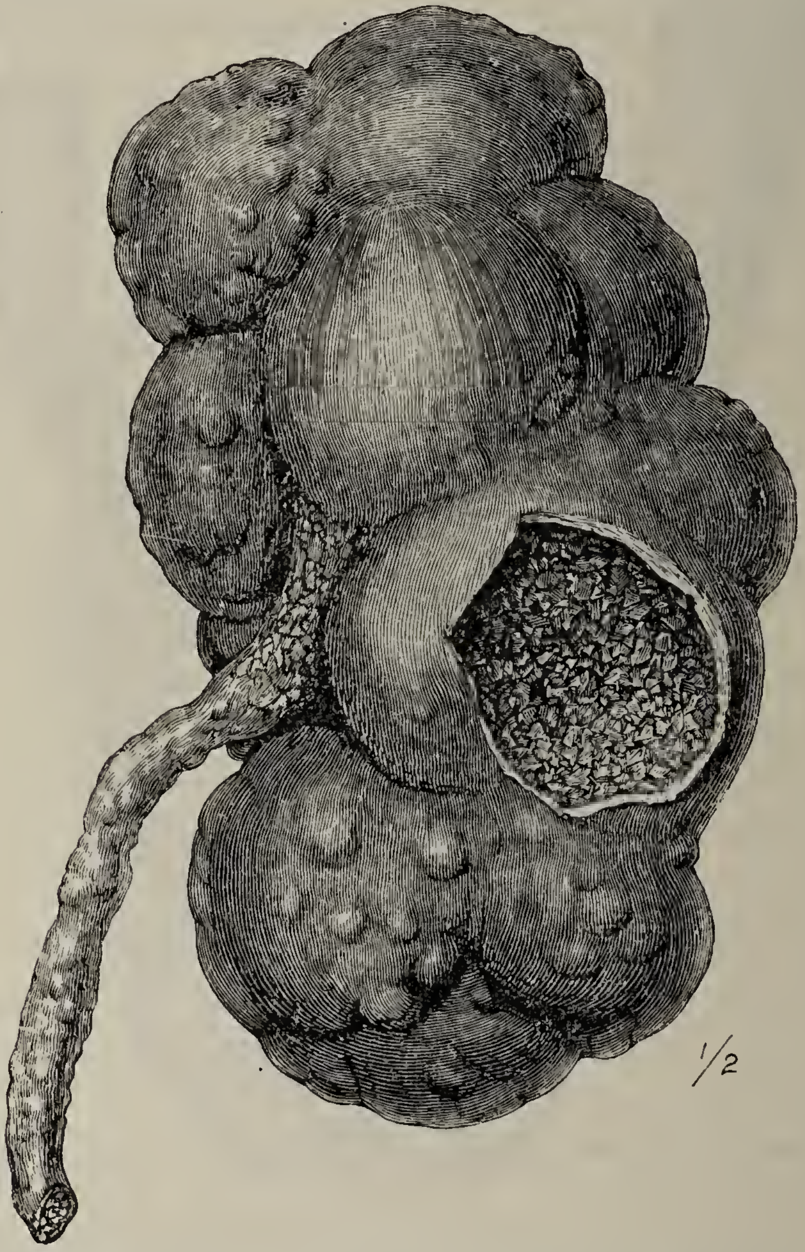

Fig. 158.—The Kidney and part of the Ureter removed during life for tuberculous disease. (Author's case.) See *Lancet*, January 1, 1898.

In a girl under my care in 1894 tuberculous ureteritis, involving the kidney and resulting in a uretero-vaginal fistula, was started by a tuberculous abscess in the pelvis connected with the uterine appendages on that side ("Hunterian Lectures," Table xii., No. 15).

The kidney, if not primarily the seat of the disease, becomes destroyed by the effects of obstruction, and hydro-nephrosis is produced. More commonly it is infected by the tubercle bacillus, and tuberculous pyo-nephrosis or tuberculous pyelo-nephritis results.

Symptoms.—The symptoms and physical signs are the same as in other forms of ureteritis, but they are more pronounced. If the individual is thin, the ureteral cord is very likely to be felt through the abdominal wall, and, if the disease involves the lower end, the ureter will be felt tender and thickened through the vagina. It is often associated with a renal tumour, a pyo-nephrosis, or a kidney enlarged by numerous deposits of tuberculous material or converted into a huge cheesy mass. The cystoscope often reveals a swollen, bulging uretero-vesical orifice, with the mucous membrane around thickened, congested, or ulcerated. The urine issuing from the ureter may be seen thick and turbid, from pus or breaking-down tuberculous material being mixed with it.

By a digital examination of the bladder the vesical orifice of the affected ureter may be felt thickened, indurated, patulous, and somewhat bulging towards the vesical cavity.

The urine has the characters mentioned in the description of tuberculous disease of the kidney (*see* p. 497, Vol. I.), and it is often passed with great frequency and intense pain. Some of the worst cases of painful frequent micturition I have ever seen have been cases of tuberculous uretero-pyelo-nephritis when the bladder itself was not involved. The urine serves as a conductor of infection to the bladder, so that secondary vesical tuberculosis may occur before the disease has spread to the vesical orifice. In other cases it spreads by continuity from the kidney to the bladder, and even from one kidney to the other.

Treatment.—Whenever the kidney is operated upon for tuberculous disease it should be ascertained if the affection has spread to the ureter. If the kidney is but slightly affected and does not of itself require to be removed, a small opening should be made in the renal pelvis, and after traversing the ureter with a catheter, to ascertain if it is permeable and if its lumen is of fair size, a thin emulsion of iodoform should be injected and pushed onwards by a bougie or catheter. If the ureter is much involved, it will be best to remove both ureter and kidney. If the kidney is removed, even though the ureter appears healthy, it will be safer to take away a short length of the ureter and tightly ligature it on the bladder side before dividing it. If the whole kidney is about to be removed and the ureter is affected, nephro-ureterectomy should be performed. If the patient is not well able to bear so extensive an operation, it may be sufficient, if the disease in the ureter is not very extrême, to divide the ureter an inch or two below the pelvic brim, leaving the rest of the pelvic portion behind. With the bulk of the disease removed, and with the remainder of the ureter no longer acting as a conduit of infected urine, there is good reason to hope that the disease in the portion left behind will abort. We often see this as the result of operations upon other organs as well as after nephrectomy. I have had cases of extensive ureteritis which have made excellent recoveries after I have removed the kidney and a large part of the ureter, but without taking away the whole length of the diseased duct; although the time required for the complete disappearance of all signs of the disease is sometimes prolonged. In extensive disease of the ureter, however, when nephrectomy alone is performed, a lumbar fistula will almost certainly result, the pyuria will continue very little abated, will go on for an indefinite time, and sooner or later death will follow.

CHAPTER IX.

STRICTURE AND STENOSIS OF THE URETER.

TWENTY-FOUR years ago, in a paper on "Intermittent Hydronephrosis,"* I collected and tabulated forty-seven cases of hydronephrosis in which abdominal tumour had been caused by the renal distension. In several instances the cause of the nephrectasis was not ascertained, but in twenty-six cases the obstruction was found situated in the ureter, and in five others calculus was present in the renal pelvis. In all the cases of renal calculus, and in a goodly number of those in which the obstacles were in or about the ureters, had the aid of the surgeon been invoked it is safe with our present experience to assert that the obstruction could have been removed without resort to nephrectomy.

The number and variety of ureteral obstructions in these twenty-six cases were as follow:—(1) A valve formed of mucous membrane and situated near the renal pelvis—two cases; in one both ureters were similarly affected. (2) Valvular formation caused by the obliquity of the ureter to the renal pelvis—seven cases. (3) Stricture, including contraction of not more than one inch in length—five cases. (4) Ureter compressed by a branch of the renal artery, abnormal or otherwise—two cases. (5) Calculus impacted in the ureter—five cases. (6) A fibrous band which passed along the brim of the pelvis from the promontory of the sacrum and compressed the ureter—one case. (7) Twist of the ureter on its own axis—one case. Both ureters were similarly involved; as soon as the ureters were dissected a little from the surrounding tissues and untwisted the accumulated urine gushed out freely from the renal pelvis. (8) Compression of the ureter by enlarged lymphatic glands situated between the uterus and the iliacus muscle—one case. (9) A considerable length of the ureter converted into an impervious cord—two cases. With the methods of operating on the ureter at the present time the renal distension from causes similar to most of the above can be remedied without making a urinary fistula.

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* *Trans. of the Royal Med. and Chir. Soc.*, vol. lix. (1876).

The pathological conditions named in the first four groups of the foregoing list are amenable to plastic operations on the ureter and renal pelvis. That of the fifth group is remediable by ureterotomy, a very successful operation for stone in the ureter, and nowadays possible no matter at what part of the ureter the calculus is impacted. A very slight operation, after the ureter is once exposed at the involved part, would suffice to remove—without cutting the ureter itself—such causes as those in Groups 6 and 7. It is only in the last two groups that we meet with causes of obstruction in which the renal distension could be permanently relieved only by establishing a fistula, or for which nephrectomy would now be adopted; and in them, nephrectomy is only to be entertained if there does not remain sufficient secreting structure to make it worth while attempting to save the kidney, or, if the other kidney being quite sound, the patient refuses to endure a urinary fistula. In this chapter attention will be drawn only to the causes of nephrectasis mentioned in the first four groups of the above list. It must be premised that a movable kidney as well as an abdominal tumour due to hydro-nephrosis is frequently an accompaniment of these conditions of the ureter. On the other hand, it is also very important to know that the degree of hydro-nephrosis is not by any means always sufficient to produce an abdominal tumour of either an intermittent or a persistent kind.

Valvular folds as well as strictures of the ureter cause intermittent, progressive impediment to the flow of urine, and sometimes result in complete and permanent obstruction. After an obstacle has lasted for a longer or shorter time nephrectasis, *i.e.* renal dilatation, results—in the form of hydro-nephrosis if there has been no septic condition of the mucosa of the ureter or infundibulum; and in the form of pyo-nephrosis if the mucosa has been from the first or becomes subsequently to the development of hydro-nephrosis the seat of infective changes. In some cases in which the degree of dilatation is considerable enough to cause a renal swelling, whether movable or not, the nephrectasis will probably be diagnosed; but its cause may not be suspected, and if suspected it is not actually ascertainable without surgical operation. When dilatation has not gone on to the extent of forming a clinically recognisable renal swelling—and this may be the case when the renal pelvis is of the size of a small orange and the various calyces are as large as nutmegs—there may be nothing either in the symptoms or in the past history of the patient to suggest ureteral stenosis; and then the diagnosis made as to the cause of the symptoms will probably be renal calculus or renal tuberculosis. In cases in which the kidney on the affected side is movable, whether nephrectasis is developed to the extent of a renal enlargement sufficient to cause an abdominal tumour or not, the mobility will most probably be credited with the symptoms, though it may be only a co-existing condition, or possibly even a result, of the stenosis. On the other hand, the mobility may have caused a valve formation in the manner to be explained immediately.

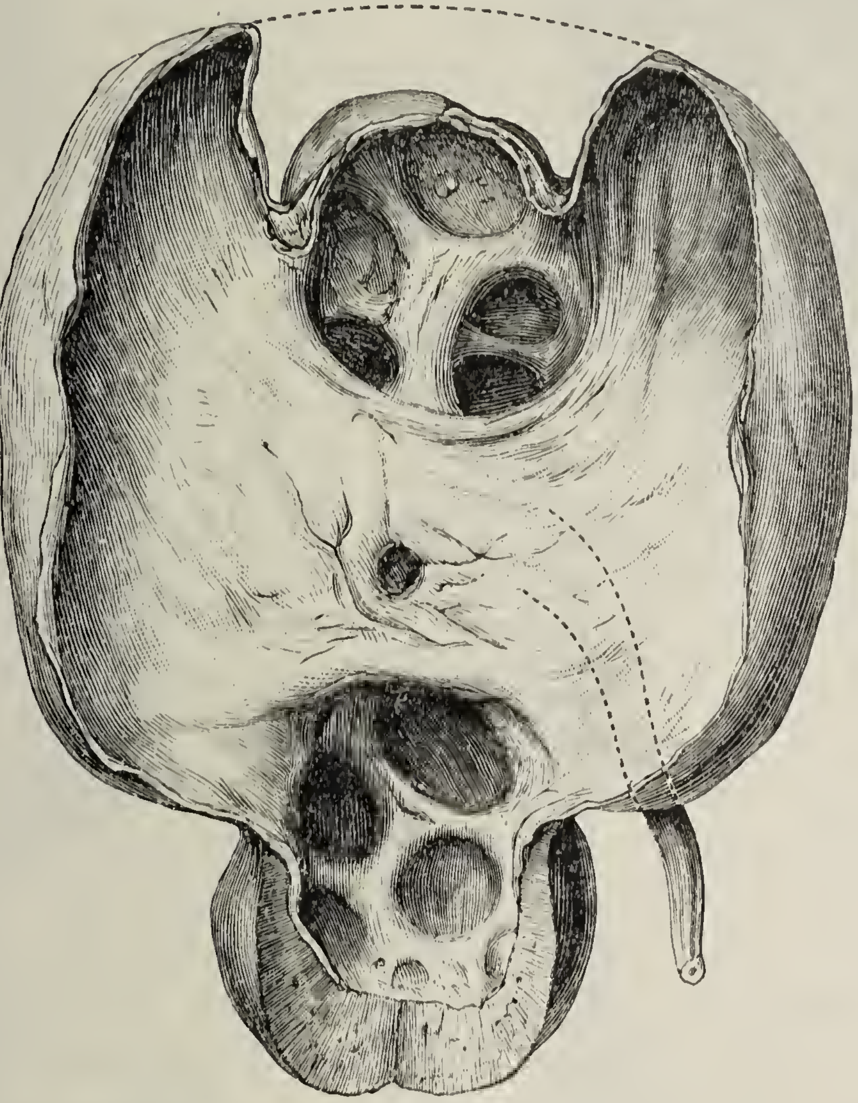

Fig. 159.—Kidney removed by the author in 1889 for Hydro-nephrosis due to Mobility. The ureter, as indicated by dotted line, passes high up on the side of the sac. Two-thirds natural size. (Middlesex Hospital Museum, No. 1767A.)

Note.—A bougie cannot be passed upwards from the ureter into the pelvis or downwards from the pelvis into the ureter, the curve at the hilum preventing. If the case had come under operation in a much earlier stage the hydro-nephrotic process might have been checked by one of the plastic operations described in this chapter.

Etiology.—The commonest situation of *valvular obstruction* is near or at the junction of the ureter and renal pelvis. The cause of valve formation is not always the same. Sometimes it is due to a congenital defect. Sometimes it is a secondary result of a morbid or mechanical change in the lining membrane of the ureter or renal pelvis. During some temporary impediment to the outflow of urine, such as is caused by pregnancy, pelvic cellulitis, uterine myoma, ureteral calculus, ureteral stenosis, or movable kidney, a unilateral dilatation may occur in the renal pelvis at a part which has less resisting power than the rest of the wall. As this unilateral dilatation increases the ureter becomes drawn up more and more along the wall of the dilated renal pelvis, and the ureteral opening becomes relatively higher and higher above the most dependent part of the hydro-nephrotic sac (Fig. 159). The ureter thus ceases to be an effective conduit for some part of the urine in the renal infundibulum. The urine in the dilated pouch of the renal cavity compresses the upper portion of the ureter, as an aneurysmal sac may compress the trunk of the vessel on which it is situated, and thus the obstruction in the upper end of the ureter is increased. It often happens, as this change in the relation of the ureteral orifice to the cavity of the infundibulum is progressing, that a valve-like process of the mucosa or a prolongation of one side of the margin of the orifice is formed, and this itself becomes a further cause of obstruction. When a movable kidney has been the original impediment, if a valve formation takes place it does so by preference at the infundibular orifice of the ureter, because owing to the fixation of the ureter to the peritoneum of the posterior abdominal wall it is here that the bend or kink in the tube is made by the recurring displacement of the kidney. Thus the obstruction affects directly the renal pelvis, and dilatation commences at the weakest part of its wall. When the initial cause of obstruction is lower down —*i.e.* within the bony pelvis or even at the vesical orifice—the effect will still be felt by the renal pelvis as well as by the ureter, and dilatation commences at the weakest spot.* This is very frequently at the infundibulum, not in the ureter at all. In the recumbent position of the body, especially, the ureter may continue full without becoming dilated and the intrarenal tension then finds out and stretches the weakest spot in the renal pelvis. This is the first step towards the formation of a valve at the upper orifice of the ureter.

The ureter in some cases yields whilst the renal pelvis and calyces escape, even to the extent of forming a large tumour (Fig. 244, p. 299). Such a condition may be due to a congenital cause; but a valve may also be formed by plication of the mucous membrane at the point at which the ureter is bent upon itself, and an intermittent hydro-ureterosis of large

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* *See* remarks by author made in November, 1893, and reported in the *Transactions* of the Medical Society of London, vol. vii., p. 81.

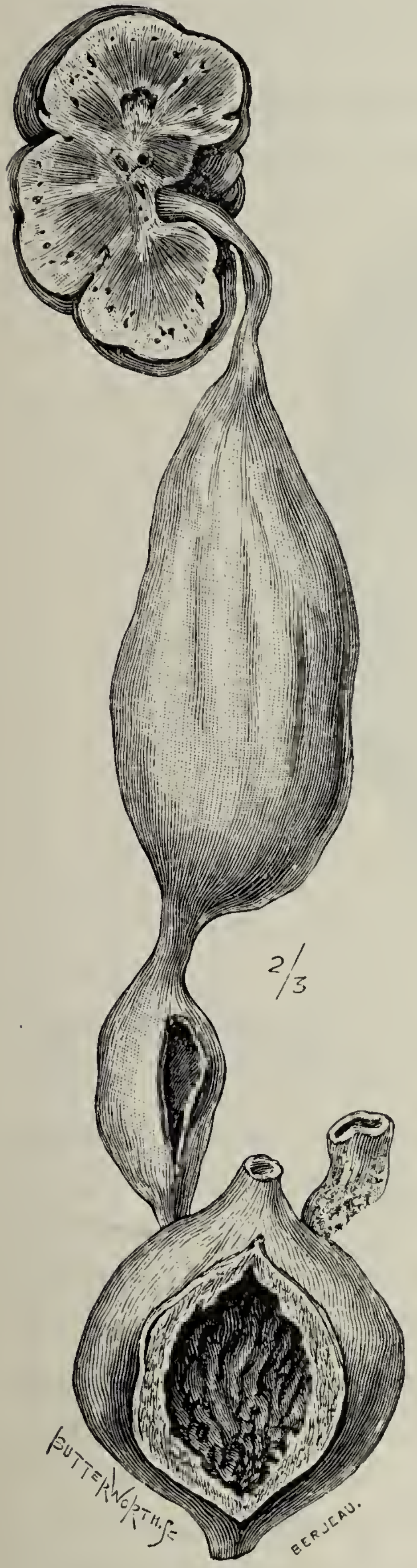

Fig. 160. — Child's Kidney, with Sacculated Ureter and Hypertrophy of the Bladder. (Westminster Hospital Mus., No. 817.)

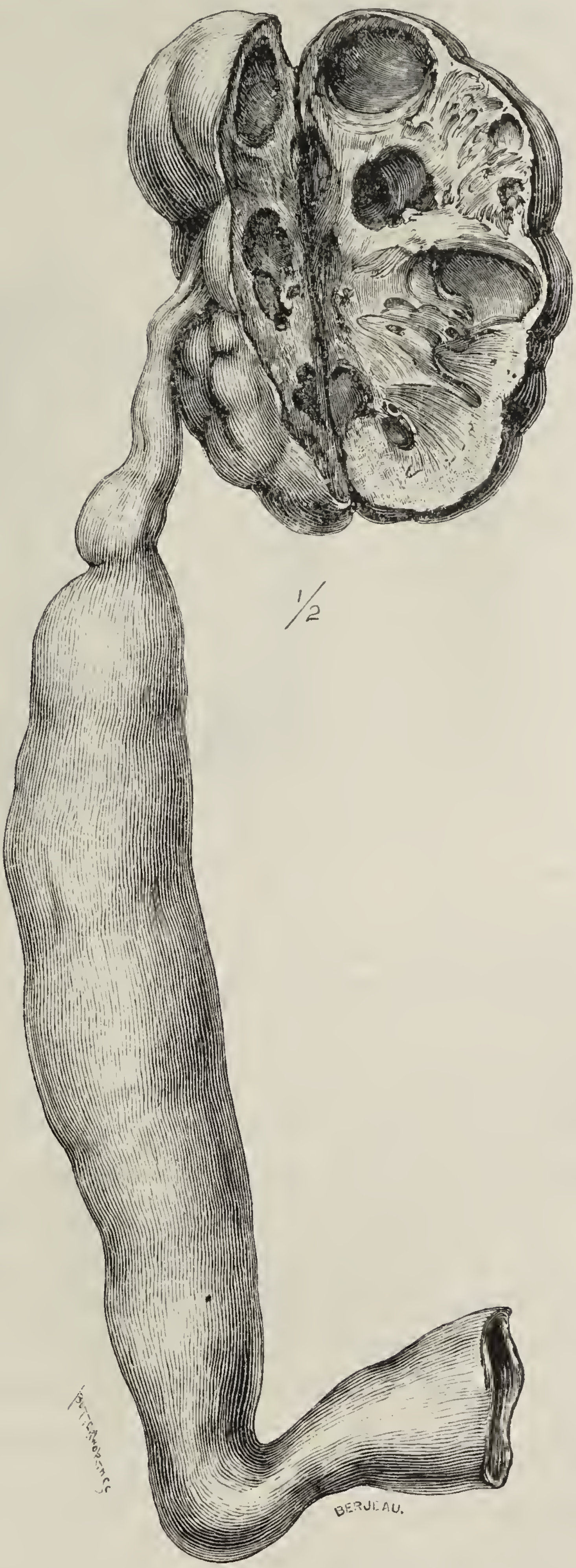

Fig. 161.—Irregular Dilatation of the Ureter. (Guy's Hospital Museum, No. 1688.)

dimensions may be the result, as in a case published by Desgranges,* and quoted by Boyer. The very unequal degree to which the ureteral walls at different parts under the same pressure will dilate and become sacculated is shown by the accompanying figures (Figs. 160 and 161), in neither of which is the renal pelvis enlarged. The absence of any change in the renal pelvis is probably explained by the readiness of the ureteral walls to yield under pressure at the parts where the dilatations have been formed. The obstruction caused by the œdema accompanying uretero-pyelitis is another occasional cause of a valve formation, the weakest part of the wall of the ureter or renal pelvis yielding under pressure in the way just described.

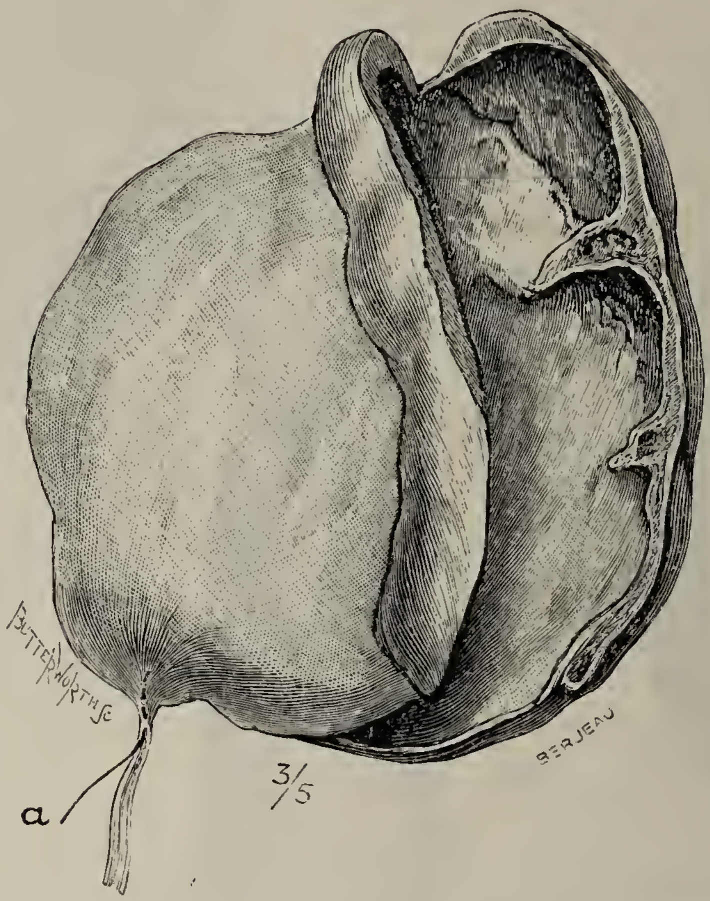

Fig. 162.—Hydro-nephrosis and Constriction of the Ureter. *a*, Constriction at the junction of the ureter and the renal pelvis. (Guy's Hospital Museum, No. 3262.)

A specimen in my possession shows the commencement of a valve by the infolding of the mucous membrane at the site of an impacted calculus. The valve looks like two semi-lunar folds compressed against the ureteral wall.

Stricture of the ureter may be situated at any part of the tube. It may be congenital or acquired. The *congenital stricture* occurs as an hour-glass contraction sometimes in very slender ureters of very small calibre and of great tenuity of structure

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* *Journ. de Médecine*, t. xcii., and Le Baron Boyer: "Traité des Maladies Chirurgicales," t. viii., p. 541 (1822).

(Fig. 160), and sometimes in tubes of otherwise normal strength and calibre. It is most frequent close to the renal pelvis (Fig. 162, and Fig. 144, p. 299). *Constrictions* are caused by *abnormal conditions of the vessels* at the hilum of the kidney. There is a specimen in St. Bartholomew's Hospital Museum (Path. Series, 2375A) of a hydro-nephrotic kidney in which the ureter was compressed by an adherent aberrant renal artery (Doran's case), and the specimens in Guy's Hospital Museum from which Figs. 141 and 142 (p. 297) were taken show a twist and a constriction of the ureter where it passes over one of the renal vessels. The illustration from the *Johns Hopkins Hospital Bulletin* (Fig. 143, p. 298) shows kinking of the right ureter where it is crossed by the right ovarian vein, but as the ureter is dilated below as well as above this spot this dilatation must have been due to the adhesions caused by the cancer of the uterus and vagina which existed, and the kinking and constriction by the vein.

The acquired strictures result sometimes from injury, sometimes from cicatrices following ulceration caused by ureteritis or from the temporary impaction of a renal calculus, sometimes from sclerosis of the cellular tissue around the ureter following an abscess or repair after an operation, and sometimes from the contraction of adhesions left after perinephritis and peri-ureteritis. In some cases, as the effect of the passage of a renal calculus or after ureteritis, the ureter may be left strictured in several places. I have seen this perhaps more often in tuberculous ureteritis, the walls of the ureter over much of its length being thickened but the tube patent throughout, and where not constricted actually much increased in diameter. By simple chronic ureteritis the tube is sometimes made sinuous in its course with sigmoid inflections, and its calibre undergoes considerable alteration, being strictured in one place and dilated at another. The strictures are constituted by folds, bridles, or valves, and occur chiefly at parts of the ureter normally narrower than the rest of the canal.

Symptoms.—Obstruction by valve formations or strictures may occur at almost any age. It appears to be most frequent in females about thirty years of age and in the right ureter; but it has been met with also in males, both boys and men. It may be associated with a movable kidney or with a tumour, either permanent or intermittent, caused by nephrectasis or by hydro-ureterosis. It is important to know that the ureter itself can become dilated sufficiently to give rise to a large abdominal *tumour* appreciable by touch and eye, and having the same physical characters as a hydro-nephrosis. In Desgranges' case the ureteral distension was to a great degree intermittent, but the swelling never entirely disappeared. It has been stated above that movable kidney may be the cause of a valve formation; but, on the other hand, there is reason to believe that a stenosed ureter, by causing obstruction to the outflow of urine and thereby adding to the weight of the kidney, may induce mobility of the kidney by increasing the dragging effect on the organ. This view is supported by cases in which patients who have been under observation or treatment for years for other symptoms due to the stenosis have shown no evidence of mobility of the kidney till a late stage. Most of the patients describe attacks of *pain* in the loin or groin, recurring at intervals of weeks or months over a period of one or many years. The pain often extends downwards over the abdomen from the hypochondrium, spreads to the hip and thigh, and to the labium in woman and the scrotum and testis in man. One female patient complained of great hyperæsthesia of the whole of the external genitals. The pain is often ushered in with vomiting or nausea, or sweating, or by a general sense of illness with fever and restlessness, or by a feeling of great coldness which has been known to continue during the greater part of the attack. The attacks of pain vary in duration, sometimes lasting only for hours, sometimes continuing with more or less constancy and severity for two, three, or more weeks. In the intervals between the attacks there may be a nearly constant dull aching in the loin; and in one of my patients who had this constant discomfort an attack was induced by every slight exertion or any exercise. In most cases there has been observed a marked decrease in the amount of urine passed during the attacks, and after a longer or shorter time an enlargement of the kidney or distension of the ureter and scanty urine may occur with each attack of pain.

The urine may be voided with difficulty and pain, and there may be frequent desire to micturate. The urine may be quite normal or may contain only a few blood corpuscles or numerous crystals of oxalate of lime, or it may be of a dark chocolate colour from the presence of blood and urates. Pus has been found in small quantities in some cases, and if the obstruction has followed an inflammatory condition of the tube or renal pelvis its presence is to be looked for. In other cases the urine deposits a thick mucus after standing and then cystitis is apt to be diagnosed and the bladder submitted to much useless treatment in consequence. In one of my cases the urine was examined every day for three weeks during an interval between two attacks and neither blood nor pus was once found, yet during a subsequent attack four months later the urine contained a large quantity of blood. This was in a patient with hour-glass contraction at the junction of the ureter and renal pelvis who had suffered pain of a sharp, tearing character in the right loin and right side of the abdomen at intervals of a month over a period of twelve years (Case 10 in table on pp. 444-45).

Tenderness in the flanks, and especially on bimanual examination, is a common symptom whether there be renal or ureteral tumour or not. The kidney, whether enlarged or not, will very probably be movable if the symptoms have existed for some months. Pressure over the front of the kidney, besides giving pain and eliciting tenderness, may cause hardening from contraction of the parietal muscles on the same side of the abdomen. If renal or ureteral distension by retained urine is present, pressure over the swelling may cause it to diminish or entirely disappear; whereupon the urinary bladder becomes distended, or a strong desire to micturate may immediately be experienced by the patient. More often however the swelling does not alter when compressed.

In some cases *the bladder* has been the seat of the earliest or the only marked symptoms, such as great frequency of micturition, inability to retain the urine, a moment after the desire is felt to expel it, pain on passing urine, sometimes so agonising as to cause the patient to scream out loudly, as in Case 1 in the table at pp. 444–45, and pain in the bladder increased by walking or movement of any kind and by the action of the bowels. In other cases the state of the bladder assumes importance at a later date, the earlier symptoms being confined to the region of the kidney itself. In others, again, the symptoms from the first have reference both to the kidney and the bladder; thus one of my patients with an hour-glass contraction at the junction of the ureter and renal pelvis had from the first intermittent periods of aching in the right kidney (which was very movable) associated with very frequent micturition, sometimes amounting to incontinence; the urine at these times became very thick and offensive and contained microscopic quantities of pus.

If the stenosis is at the vesical end of the ureter the bladder symptoms are perhaps more likely to predominate, but it should be remembered that they are also excited by obstruction at the upper end of the tube. Occasionally an irritation or a feeling of constriction in the rectum has given rise to a suspicion of stricture of the bowel.

The local symptoms are sometimes much increased at the menstrual period, and when recurrent may only appear at these periods. If the kidney is movable, the attacks are less likely to be attributed to the pelvic organs, because it is quite common for the symptoms of movable kidney to be aggravated at the time of the catamenia. If the kidney is not movable, a mistaken diagnosis is probable; the uterus has been uselessly treated for displacements and the uterine appendages removed without any beneficial result.

When a stricture is situated in that portion of the ureter which is within or below the broad ligament, vaginal palpation may assist towards a correct diagnosis. The ureter may be felt cord-like and tender in the cellular tissue about the anterior and lateral fornix of the vagina, and along its course from the neighbourhood of the cervix uteri backwards, outwards, and upwards, towards the wall of the bony pelvis, for an extent of three inches. This cord is sometimes very distinct, as large as or larger than a No. 12 English catheter, and can be rolled about under the finger tip; or the strictured part has been felt like a hard, nearly immovable mass and mistaken for an inflamed adherent ovary. But similar conditions of the ureter are produced by tuberculous and other forms of ureteritis.

The cystoscope probably reveals nothing, but catheterisation of the ureter may detect a stricture, especially when situated near the vesical end. On passing the ureteral catheter from the bladder it will meet with resistance, and on withdrawal will very likely be grasped by the stricture like a catheter when withdrawn through a urethral stricture.

When the stenosis is situated at or near the renal end of the ureter and there is no nephrectasis, or ureteral retention of urine, catheterisation of that tube can afford no information in the absence of pus or blood in the urine from that kidney alone; nor is it probable that a simple valve formation at any part of the tube could be detected by upward catheterisation. If

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* *See* Kelly's case, *Johns Hopkins Hospital Bulletin*, vol. xi., Sept., 1890, No. 234.

the catheter is used, its correct course along the ureter should be verified by retaining the instrument sufficiently long to allow of the escape of a little urine through it. Kelly has pointed out that when there is dilatation of the ureter above the stricture this condition can be diagnosed by drawing off with the ureteral catheter in a few minutes such a quantity of fluid as it is manifestly impossible for the kidney to secrete in that length of time.

The *general symptoms* to be looked for are of a neurasthenic and gastro-intestinal character. These are an indisposition to any form of exercise or exertion and a great sense of muscular weakness. A languid feeling between the attacks is often complained of by these patients. They lose flesh and get all sorts of dyspeptic symptoms brought on by the pain and spasmodic attacks, by the troubles of micturition, and by the loss of rest and the frequent confinement to bed or the bedroom to which their sufferings constrain them.

If the kidney is movable or a renal tumour is caused by the nephrectasis, any of the symptoms described under these headings may be present.

Treatment.—In every case in which symptoms exist and are thought to be due to a valve formation or to a single stricture of limited extent, and in which nothing abnormal about the ureter can be felt by vaginal or rectal palpation, an exploration of the kidney and ureter through the loin should be made. The surgeon should not wait for mobility of the kidney or a distension tumour to be superadded to the other signs. If these cases were operated upon early, there is good reason to believe that a certain number of movable kidneys would never have become mobile, and very certainly nephrectasis and ureterectasis would be less frequently met with. It is very interesting to compare the present day practice and teaching with the following view expressed by Boyer* in 1820: "The dilatation of the ureter is an incurable disease which almost always kills when it reaches the stage of tumour. The opening of the swelling can only accelerate death; therefore, when there is reason to think that a swelling in the iliac region is caused by a dilated ureter it is necessary to guard against its being opened."

The operation.—When the kidney is exposed and separated from its investing fatty tissue it will very frequently present a tense cystic swelling of the renal pelvis of the size of a Tangierine orange or larger, and the kidney substance may be felt to be more or less flaccid, and thinner than normal. This is often found to be the condition on exploration in cases in which clinically no renal enlargement has at any time been discovered. The contents of the sacculated kidney should now be let out through a small incision in the back of the renal pelvis. A calculus should be sought for by palpating the whole kidney between the fingers and thumb and then by invaginating the renal pelvis on the tip of the finger introduced at the hilum of the kidney. If there is nothing to indicate the presence of even a minute renal calculus the renal parenchyma need not be incised, but the upper inch or more of the ureter should be cleared. If there be a stricture or an hour-glass contraction at or near the junction of the renal pelvis and ureter, it will now be seen. If a valve formation exists, there may be no indication whatever of it on the outside, or there may be a constriction or a thickening on the ureteral wall. If the ureter is obstructed by an abnormal arrangement of the renal vessels at the hilum, this will now be seen. If no cause of obstruction is visible the ureteral catheter should be introduced through the opening in the back of the renal pelvis and passed along the ureter towards the bladder. Should the catheter reach the bladder without meeting with resistance and the kidney be very movable, the inference will be that the kinking or twisting of the ureter from time to time by the movements of the kidney has been the cause of the symptoms, and that nephropexy is all that is required. I have seen in some cases of intermittent obstruction from movable kidney a spiral twist impressed on the ureter, or an indentation with local thickening of the wall near its junction with the renal pelvis, and yet a bougie readily traversed the lumen of the duct from the renal pelvis to the bladder.

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* "Maladies Chirurgicales," p. 547.

If there is a valve formation, of which, be it remembered, no trace may exist on the outside of the ureter or renal pelvis, the catheter as it is passed will meet with the obstruction. There is often a little difficulty in at once hitting off the ureteral orifice; this is, however, easily overcome by making the ureter taut and steadying the point of the bougie between the left fore-finger and thumb placed on the outside of the upper end of the ureter; but in several instances of nephrectasis—especially when the ureter is adherent in part of its length to the wall of the cyst —it is impossible to pass the instrument downwards owing to the valve-like fold of mucous membrane at the ureteral orifice which impedes the catheter, as it does the natural flow of urine from the renal pelvis. This was so in the case from which Fig. 163 was drawn. When this is the case an incision should be made in the ureter just below the obstruction, through which a bougie should be passed upwards into the renal pelvis if possible (it is not always), as a preliminary step to the division of the stricture or valve.

If in addition to the sacculation of the kidney and the distension of the renal pelvis the ureter also is dilated, or if the ureter alone is dilated, the obstruction will be found lower down; sometimes in the abdominal section of the ureter, but much more likely below the brim of the bony pelvis; probably close to or at the vesical orifice of the ureter, or in the female between the folds of the broad ligament.

1. Supposing the stenosis to be due to a valve or hour-glass contraction or stricture at the common situation—viz., at or near the pyelo-ureteral junction—the cause of obstruction should be divided by a longitudinal incision, extending through the tissues to a little way above and a little way below the stenosed area. Then the angles of the longitudinal incision should be drawn together by means of a fine silk suture carried in a small needle, straight or curved, as is found most convenient; this done, the longitudinal wound is converted into a transverse one, and one or more additional sutures are inserted to close it securely. If the walls of the tube are thick enough to give a sufficient hold to the sutures, the mucous lining should not be penetrated by them; otherwise the sutures must pass through the whole thickness of the walls. The ureteral bougie or catheter should then be withdrawn, and the small wound in the renal pelvis or ureter below the obstruction through which the bougie was introduced should be closed by one or more transverse sutures passed in the manner of Lembert. There is little fear after this operation, if the ureter be of normal calibre, that subsequent obstruction will follow from contraction of cicatricial tissue. The retention of the bougie within the ureter for two or three days is not to be recommended; it delays healing, and it is liable to be followed by a temporary fistula. It is apt to excite ureteritis, and there may be marked difficulty in removing it owing to deposit of urinary salts upon it.

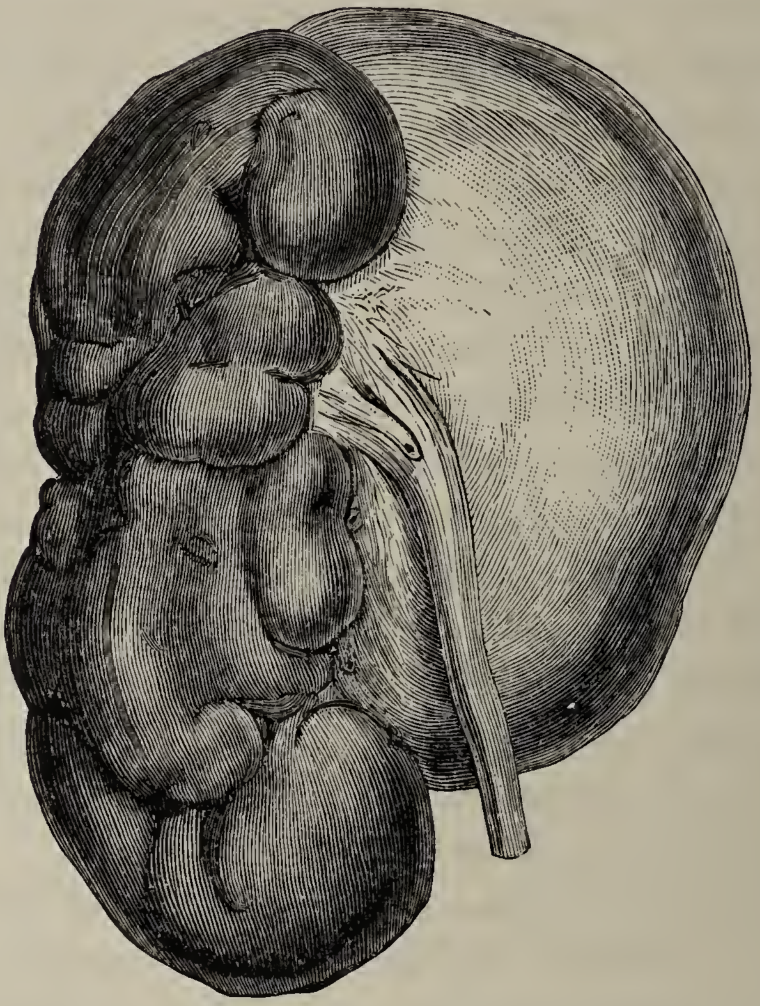

Fig. 163.—Kidney removed during life, but which might in an earlier stage have been treated by Pyelo-ureterotresis. (Author's case.)

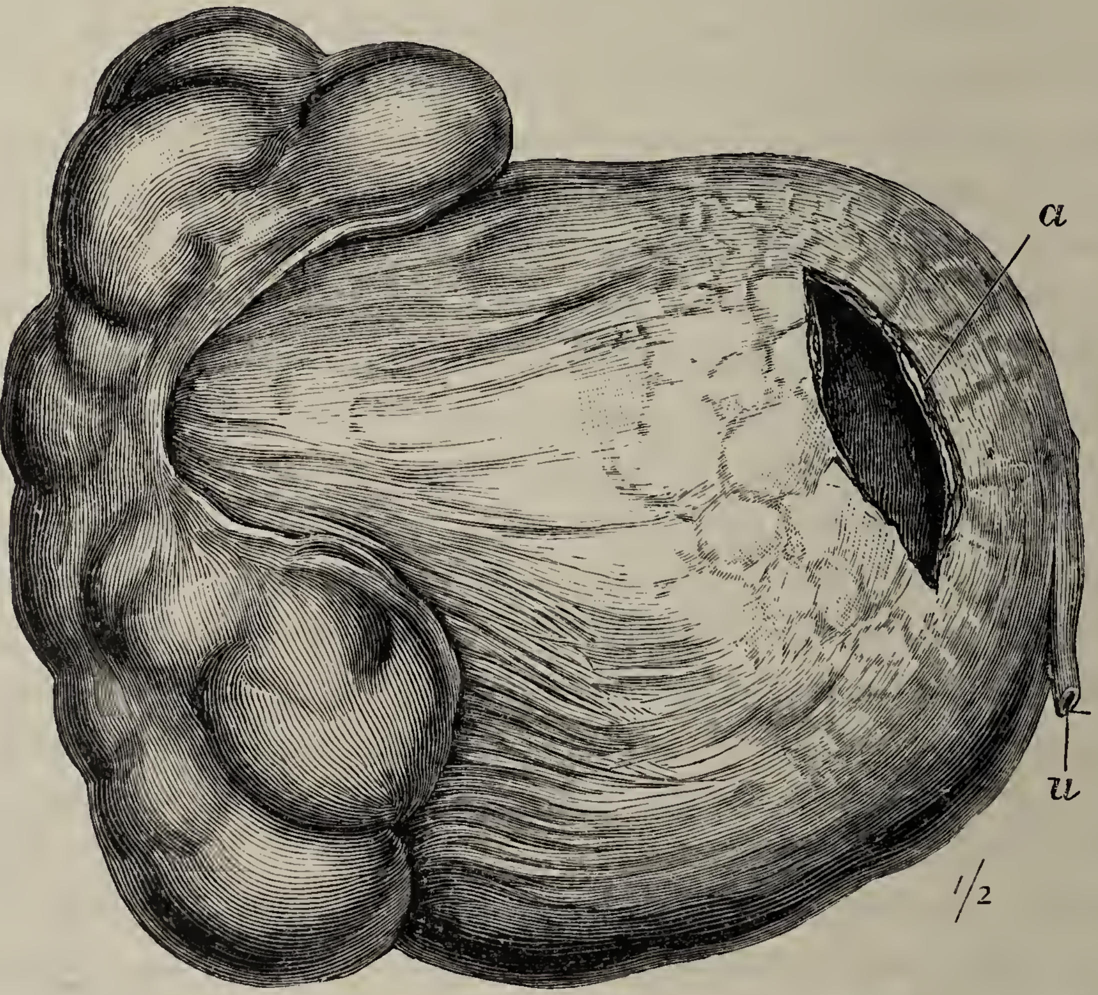

Fig. 164.—Pyo-nephrotic Kidney, removed during life, but which might have been remedied before it became septic by Pyelo-ureterotresis.

a, Incision into dilated renal pelvis ; *u*, ureter.

2. When the ureter is adherent to the wall of the hydro-nephrotic sac, and opens some distance up in the side of it, the ureter should be divided down to the lowest part of the sac and its divided edges should be sutured with fine silk sutures passed by Lembert's method to the divided borders of the lowest part of the sac (*see* Fig. 165). In this way the ureteral opening is removed from the side to the bottom of the renal pelvis and remains quite patent. In cases in which the ureter is running up some distance upon the hydro-nephrotic sac and a valve-like fold projects over the entrance from the renal pelvis into the ureter, the valve may be divided from the inner side. This is done by making an incision of from three-quarters of an inch to an inch in length through the posterior wall of the renal pelvis; whilst holding this open with forceps the valve should be divided with scissors or with a tenotomy knife by cutting through the mucosa and muscular wall of the renal pelvis and ureter, but without cutting into the surrounding cellular tissue. The ends of the incision should be united by sutures passed from without through the cellular and muscular layers of the wall, but not, if it can be avoided, through the epithelial lining. The opening into the ureter is thus much enlarged and brought down to the lowest part of the sac. The opening in the posterior wall of the renal pelvis is now closed by one or two sutures passed across the line of incision (Fig. 165).

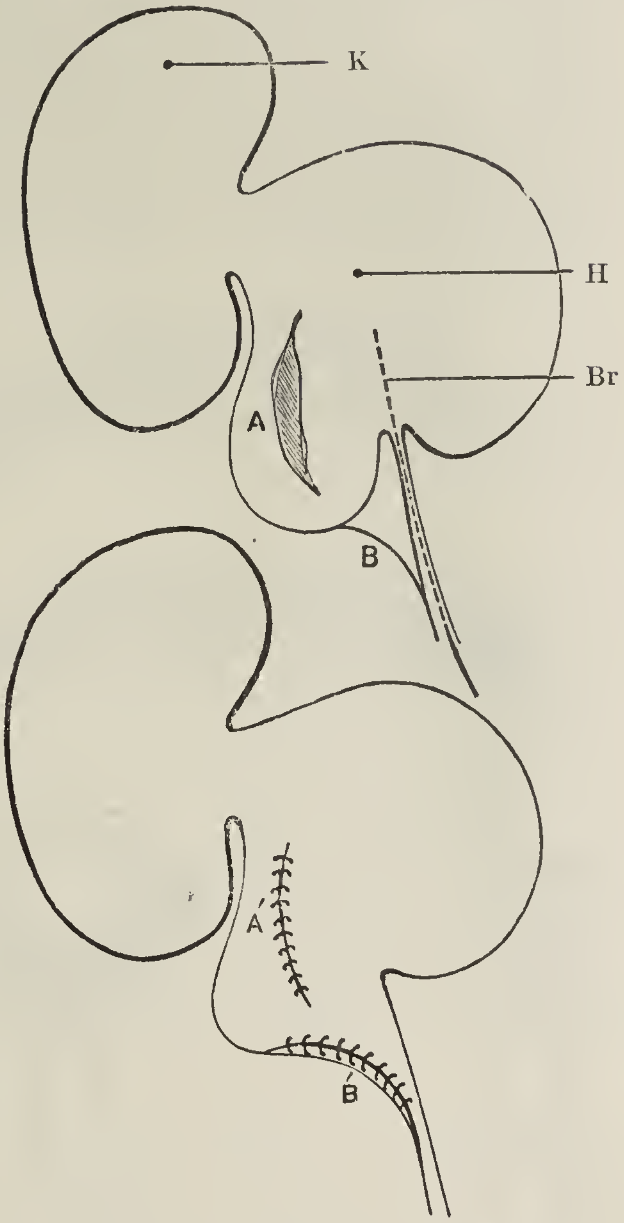

Fig. 165.—Modified from Minter's diagrams. These figures show how, by slitting down the wall of the sac and of the ureter, and suturing the trimmed edges of the incision together by several sutures, the ureteral orifice becomes a long, funnel-like opening at the bottom of the sac.

A, Opening in sac wall, and B, position for incision (before operation); A′ and B′, after operation. (*Note.*—The sutures are too numerous in the illustration.) K, Kidney; H, hydro-nephrotic sac; Br, bristle passed through the ureter into the sac.

3. When, in addition to the ureter opening on the side of the hydro-nephrotic sac, a stricture occupies the ureter a little lower down, Küster's operation should be followed. This consists in resection of the involved part of the ureter and implantation of the divided duct into the lowest part of the renal pelvis. It is advisable to split the ureter a little way before joining it to the renal pelvis, as Küster did, so as to increase the size of the ureteral aperture (Fig. 166).*

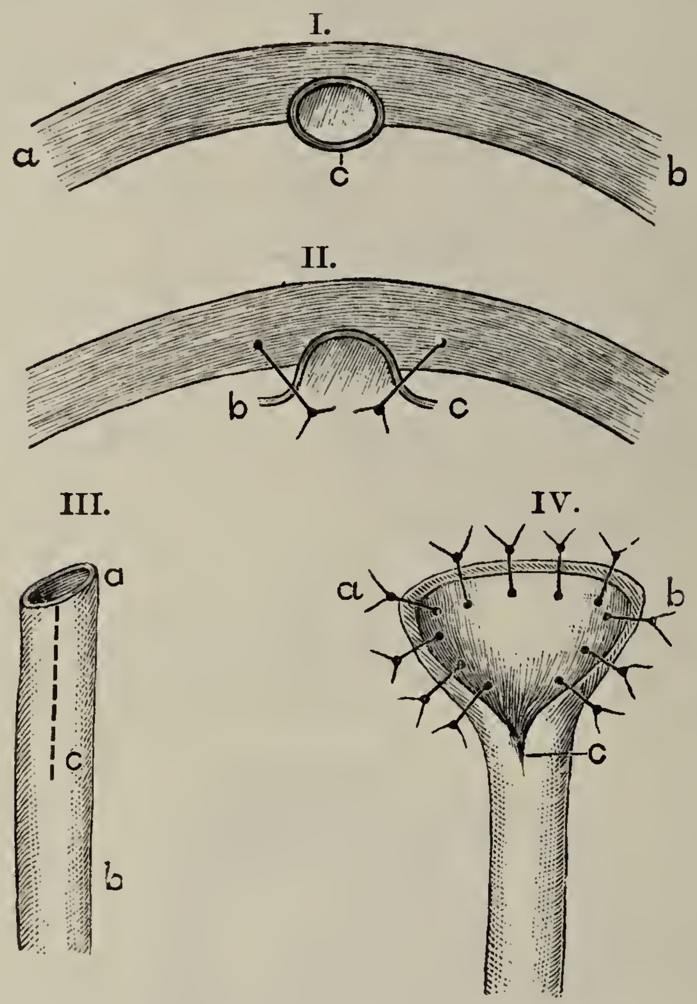

Fig. 166.—Showing Küster's Operation.

I.—*a*, *b*, Sac wall; *c*, transverse section of ureter. II.—*b*, *c*, the ureter in transverse section on split anterior side. At *b* and *c* eleven sutures which connect the wings of the split ureter to the wall of the sac. III.—*a*, The upper mouth of the ureter running in the wall of the sac, *a*, *b*; *a*, *c*, split line of the same in the anterior part of the canal. IV.—The cleft walls of the canal pulled apart and fastened at *a*, *b*, *c* flat on the wall of the sac.

I adopted resection in Case 7 of the list on p. 444, but abandoned it when completed for nephrectomy, because the age and general condition of the patient, together with the extreme tenuity of the ureter, made me doubtful of success.

If the stricture is so long that the cut ends of the ureter cannot be brought together after resection, or if the stricture involves the part of the ureter within the bony pelvis and the proximate end cannot be brought to the bladder to be there grafted, resection is out of the question, as it will be impossible to re-establish the passage from the kidney to the bladder. Before performing any of these operations the patency of the ureter in the rest of its course must be ascertained, for if the ureter cannot be made patent throughout its course, these operations are useless.

When an abnormal renal vessel is the cause of constriction the vessel should be divided; or the ureter should be divided and sutured into the pelvis afresh (uretero-pyelo-neostomy) in such a case as is figured on p. 297 (Vol. II.); or uretero-ureteral anastomosis should be done when the constriction is lower down, in such a case as Dr. Blumer's (p. 298, Vol. II.).

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* See *post*, p. 557, for full description of the operation.

4. Alsberg,* after performing lumbar nephrotomy in a case of left hydro-nephrosis, kept open a fistula and dilated the ureter by bougies passed through the wound. For ten days after the nephrotomy all urine passed through the wound, then it began to pass by the bladder. Some months later the lumbar fistula was closed and the result seems to have been good, as the hydronephrosis did not reappear. This method involves a long convalescence with a prolonged temporary fistula; there is the risk of re-contraction of the stricture, and the method is not applicable to cases of valve formation. One of the other methods (Nos. 1, 2, or 3) is to be preferred. With any of the operations just described, if the kidney is movable, nephropexy ought to be performed at the same time.

When the stricture is situated below the brim of the true pelvis it cannot be reached by an incision in the loin, and if a plastic operation is to be performed the pelvic portion of the ureter must be exposed by one of the methods now resorted to in performing ureterotomy. Such an operation must be done or a lumbar fistula must be established if the opposite kidney is not in working order; but if the opposite kidney is sound and the kidney on the affected side is in an advanced state of hydronephrosis—nephrectomy should be performed (Case 11 in the Table at p. 444).

Catheterisation.—When the stricture is close to the bladder, dilatation by fine bougies passed upwards from the bladder has been tried. Strictures of the ureter are reported to have been cured in this way by Pawlik and Kelly. Pawlik's case † was one of pyo-nephrosis, and a cure was effected after thirty successive soundings. In a case recorded by Kelly the patient was catheterised six times at intervals of ten or twelve days; every introduction of the catheter was followed by most marked aggravation of previously existing pain, each exacerbation lasting some days. Though temporary relief followed, the symptoms again returned and a uretero-vaginal fistula had to be established.

Ureteral catheterisation in the treatment of stricture is not to be recommended; it is a difficult procedure, and one which is revolting and painful to the patient. Sometimes it is excruciatingly painful in its after effect. To be of any benefit it must be frequently repeated, and the result has not been permanent even after continuous treatment for many months and the introduction of the catheter more than a hundred and twenty times.* Moreover, in one case at least in which the catheter was employed upon a stricture situated just below the pelvis of the kidney the vesical orifice of the ureter was torn and subsequently became completely closed. Urinary fever is an occasional consequence of ureteral catheterisation—shivering, a temperature of from 102° to 104° F., with rapid pulse, headache, sleeplessness, nausea, and pain in the regions of the side catheterised being experienced.

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* *Verhandlungen der Deutschen Gesellschaft für Chirurgie*, XXI. Congress, 1892," p. 43; and *Arch. f. klin. Chir.*, xliv., 1892, p. 850.

† Albarran and Lluria, *Comptes Rendus de la Société de Biologie*, 1891, vol. iii., No. 24, p. 543; No. 26, p. 587.

Colpo-ureterotresis.—After the failure of other treatment, aided by the establishment of a vesico-vaginal fistula in a case of ureteral stricture of the left ureter about on the level of the cervix uteri, Kelly opened the ureter longitudinally by an incision three inches in length through the antero-lateral vaginal wall, and the mucosa of the ureter was sutured to the vaginal mucosa, thus establishing an orifice high up in the vagina to the left, four inches from the external urethral orifice and just in advance of the cervix. The strictured part of the ureter was just above this orifice and was dilated by means of a pair of delicate curved forceps passed through the orifice.† We are not informed of the ultimate result of this operation beyond the significant fact that twice subsequently there was a return of all the old symptoms owing to small calculi becoming impacted in the ureteral orifice, and that a catheter was passed from time to time through the stricture, apparently for the purpose of keeping up dilatation. All the objections to a uretero-vaginal fistula are attached to this treatment, and with the fistulous opening on the distal side of the stricture there is further the necessity of subsequent catheterisation to keep the stricture dilated. The operation cannot be recommended. If the other kidney is sound, nephrectomy should be performed, and if not and a vesical grafting cannot be done or fails, a lumbar fistula is preferable. A permanent lumbar fistula is to be preferred to a uretero-vaginal fistula because the fistulous opening on the loin can be more readily kept clean and aseptic and a portable urinal can be more conveniently worn there than over the vulva.

Uretero-ureteral anastomosis and ureteral grafting.—When the obstruction is within from one and a half to two and a half inches of the bladder and it is necessary to save the obstructed kidney, one of the methods of uretero-vesical grafting should be tried before establishing a permanent fistula either in the vagina or loin; but with a sound kidney on the opposite side and an advanced hydro-nephrotic condition of the obstructed kidney nephrectomy is the best treatment, though not otherwise.

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* Kelly's "Operative Gynæcology."

† Kelly, *Johns Hopkins Hospital Bulletin*, vol. ii., Sept., 1890.

Nephro-ureterectomy.—When a great length of the ureter is infiltrated with inflammatory or tuberculous material and is widened and rigid in some places and strictured or contracted in others, it is not probable that anything short of nephro-ureterectomy will be of any use.

Ureterotomy for stricture was performed by Fenger of Chicago in November, 1892,* on a man, aged forty-seven years, with stricture of the ureter close to the renal pelvis. Fenger first did lumbar nephrotomy and found the kidney sacculated, but could find no stone in the calyces or renal pelvis. The ureteral entrance could not be found through the wound in the kidney. The dilated pelvis was then incised on its posterior aspect, but still the opening of the ureter could neither be seen nor felt. The ureter was then isolated. Its upper end for half an inch was found to be embedded in cicatricial tissue. Lower down the ureter was normal. A longitudinal incision one centimetre in length was made in the ureter just below the cicatrix. The sound could now be easily passed down into the bladder, but when passed upwards its progress was stopped by a stricture situated immediately below the renal pelvis. The stricture was one centimetre in length and the ureter below it was somewhat narrowed. The stricture was then incised upwards into the pelvis. A plastic operation was performed similar to that of Heinecke-Mikulicz for stenosis of the pylorus—the ureter being united to the renal pelvis on that principle. The pelvic wound was united by sutures. No bougie was left in the ureter. A drainage-tube was passed into the renal pelvis through the wound in the kidney. The patient was well in six weeks.

Ureterotomy for valve formation.—Simon was the first to propose to operate for this condition. His suggested method was by the abdominal route.† Trendelenburg in 1890 was the first to make the attempt, also from the front of the abdomen. This he did by lateral laparotomy.* He opened the anterior wall of a large hydro-nephrotic sac, saw the ureteral opening on the side of the sac, and having divided the duct vertically downwards, he sutured the divided borders of the ureter to the inner wall of the lowest part of the sac. The ureteral opening was thus displaced from the side to the bottom of the sac in order to keep the ureter patent. The result of this operation is uncertain, as the patient died from ileus.

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* Case 4, *Chicago Medical Recorder*, vol. iv., No. 3, p. 165, new series, March, 1893. No. 4 in subjoined Table.

† *Chir. der Nieren*, vol. ii., Stuttgart, 1876.

Fenger † was the first who successfully operated by the retro-peritoneal route. His patient was a woman, aged twenty-eight years, who was suffering from a somewhat floating kidney and intermittent pyo-nephrosis supposed to be due to stone. On May 31st, 1892, nephrotomy was performed through the convex border of the kidney—no stone was discovered. Catheterisation of the ureter through the incision in the kidney was found to be impossible. The renal pelvis was opened on its posterior surface and a valvular opening from the pelvis of the kidney into the ureter was discovered. "The valve was divided transversely and the ends of the incision were united by a suture. A bougie was inserted through the wound in the kidney and brought down into the ureter and retained there for two days. The wound in the pelvis was united by sutures. The floating kidney was secured by nephrorraphy and the wound in the kidney drained. The patient recovered without a fistula and up to the time of publishing (March, 1893) had had no return of the pyo-nephrosis."

The second successful operation was performed by Herman Mynter on August 14th, 1893, on a man, aged twenty-five years, with intermittent hydro-nephrosis of twelve years' duration and valvular stricture of the pelvic orifice of the ureter. Calculus was diagnosed as the cause of the obstruction, but none was found on exploratory nephrotomy. Mynter describes his operation thus: ‡ "After the kidney was exposed a fluctuating swelling was seen as large as an orange, below and to the inside of the kidney, containing a clear watery fluid, and being a hydro-nephrosis. An incision an inch long was made in its lower end and about half a pint of fluid was evacuated. The finger was introduced and the kidney was explored for stone, but none was found. By spreading the incision laterally the opening of the ureter could be seen plainly. It appeared as a papilla extending a quarter of an inch into the cavity. A flexible bougie, No. 14, French scale, was introduced with ease into the bladder, showing the ureter to be permeable through its whole length. I could find no other cause for the recurrent hydro-nephrosis than this abnormal condition of the ureter. The kidney was not more movable than normally. I therefore enlarged the incision downward through the papilla and well into the healthy ureter, pulled the margins of the wound outwards with fine hooks, and united the wound longitudinally with numerous fine silk sutures, taking in the outer two coats of the ureter and sac, and avoiding the mucous membrane. After the wound was sutured the appearance was more that of a funnel."

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* Volkmann, *Sammlung klinischer Vorträge*, No. 355, 1890, p. 3378. No. 12 in subjoined Table.

† *Op. cit.* Case 3 in accompanying Table.

‡ *Annals of Surgery*, Dec. 1893. Case 6 in accompanying Table.

TABLE OF CASES OF OPERATION FOR STRICTURES

No.	Surgeon and Date.	Sex and Age.	Nature and Situation of Obstruction.	Right or Left Side.	Leading Symptoms.
1	Kelly (*Johns Hopkins Hospital Bulletin,* September, 1890, p. 234).	F.	Stricture found situated about opposite to the cervix uteri.	Left side.	Great pain and irritability of the bladder, aggravated at menstrual periods.
2	Küster (*Archiv für klinische Chirurgie,* xliv., 1892, p. 850).	M., 11 years.	Two strictures present : one at the junction of the ureter with the renal pelvis and the other about two centimetres lower down.	Left side.	Long-standing hydro-nephrosis.
3	Fenger, May, 1892 (*Chicago Medical Recorder,* March, 1893, p. 164).	F., 28 years.	Valvular stricture of the renal pelvic orifice of the ureter in a somewhat floating kidney.	Left side.	Frequent attacks of pain, with occasional presence of a tumour. Occasional pyuria.
4	Fenger, Nov. 26th, 1892 (*Chicago Medical Recorder,* March, 1893, p. 165).	M., 47 years.	Stricture one centimetre in length just below the pelvis of the kidney. Supposed to have been of traumatic origin.	Left side.	Intermittent hydro-nephrosis with pus in the urine.
5	Van Hook (*Journal of the American Medical Association,* Dec. 16th, 1893).	M., 13 years.	Valvular obstruction just below the renal pelvis.	Left side.	Pyo-nephrosis.
6	Mynter, 1893 (*Annals of Surgery,* December, 1893, p. 658).	M., 25 years.	Valvular obstruction at the junction of the ureter and renal pelvis.	Right side.	Periodical attacks of pain every two or three months for 12 years. Urine scanty during attacks. Microscopically oxalate of lime crystals and a few blood corpuscles found.
7	H. Morris, Oct. 22nd, 1897.	F., 57 years.	Ureter found running obliquely in the wall of the renal pelvis, which was dilated.	Left side.	Symptoms for nine years Intermittent hydro-nephrosis.
8	H. Morris, February, 1898.	F., 29 years.	Stricture at the junction of the ureter and renal pelvis; barely admitted the smallest ureteral catheter. Pelvis of kidney distended to the size of a cricket-ball.	Right side.	Intermittent pain for five months. Tenderness in loin. Very frequent micturition and pyuria.
9	H. Morris, April, 1898.	F., 30 years.	Valve-like ingrowth obstructing ureter just below the pelvis of the kidney.	Right side.	Paroxysmal attacks of pain in the right loin for ten months. Hæmaturia and pyrexia.
10	H. Morris, November, 1898.	F., 30 years.	An hour-glass constriction of the ureter just below the renal pelvis. Kidney hydro-nephrotic.	Right side.	Attacks of pain accompanied by diminished urine and sometimes hæmaturia. Pain and tenderness over the region of the kidney on palpation.
11	H. Morris, May, 1899.	F., 29 years.	Tight stricture found in the ureter situated about an inch and a half below the brim of the true pelvis. Kidney hydro-nephrotic and movable.	Right side.	Attacks of pain accompanied by diminished urine.
12	Trendelenburg, 1890.*	—	—	—	—

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* For details of this case *see* the text, pp. 441–2.

AND VALVULAR OBSTRUCTIONS OF THE URETER.

Mistaken Diagnosis.	Nature of Treatment.	Result.	No.
Thought at first to be due to cystitis. Later considered as ovarian and the ovaries were removed.	A uretero-vaginal fistula was established and the stricture was dilated through the opening.	Permanent fistula resulted.	1
—	Resection of the ureter. Part of the ureter with stricture excised and the end sutured to the renal pelvis. (The patient had only a single kidney, and for two years had passed all his urine through a fistula following lumbar nephrotomy.)	Recovery. Fistula closed and urine was passed naturally.	2
Diagnosis: intermittent pyo-nephrosis, stenosis in the pelvis or ureter; possibly from stone.	Kidney incised and explored. Valvular obstruction reached through posterior surface of ureter; divided transversely and the ends of the incision united by sutures. A bougie inserted through the wound in the kidney and brought down into the ureter and retained there for two days.	Disappearance of symptoms. Complete recovery.	3
Thought probable that a calculus was present.	Stricture incised and sutured by the Heinecke-Mikulicz method.	Good recovery. Wound healed perfectly.	4
Possibility of calculus.	Resection of the strictured part and implantation of the end of the ureter into the sac performed, but found useless, as another stricture was discovered lower down. Nephrectomy was therefore performed.	Recovery.	5
Thought to be due to renal calculus.	Kidney hydro-nephrotic. Valve divided longitudinally and the edges pulled outwards and united to the sac of the pelvis so as to form a funnel-shaped opening.	Good recovery. Wound healed well.	6
Had been diagnosed in Glasgow as a case of calculus.	Resection of the ureter. Excision of three-quarters of an inch of the ureter performed and the edges sutured to the renal pelvis; but afterwards on account of the small calibre and extreme tenuity of the ureter it was considered best to perform nephrectomy. Kidney very small and sacculated.	Recovered.	7
Symptoms thought to indicate renal calculus.	Constriction of the ureter longitudinally divided upon a catheter, and ends of incision drawn together by the Heinecke-Mikulicz method. Nephropexy also performed, as the kidney was movable.	Wound healed by first intention. Entire disappearance of symptoms. Is quite well and was delivered of full-time infant in March, 1899.	8
Symptoms thought to indicate renal calculus.	Constriction incised longitudinally and the ends united by the Heinecke-Mikulicz method.	Total disappearance of symptoms. The patient reported herself as quite well in Jany., 1901. Urine normal. Since the operation she has given birth to a healthy child.	9
Symptoms thought to indicate renal calculus.	Stricture divided by a longitudinal incision a quarter of an inch in length. Ends joined by the Heinecke-Mikulicz method.	All symptoms disappeared. The patient reported herself on June 6th, 1899, quite well; the scar of the incision firm; no pain or tenderness.	10
Symptoms thought to be due to calculus.	Nephrectomy. The kidney was so extremely wasted it was not worth saving by extending the abdominal incision downwards nearly to Poupart's ligament, as would have been necessary in order to divide the obstruction.	Patient made an uninterrupted recovery and is now quite well.	11
—	—	—	12

CHAPTER X.

CALCULUS IN THE URETER.

By ureteral calculus, or calculus in the ureter, is meant a calculus which, formed in the kidney, has become impacted in the ureter. Renal calculi, while yet small, and especially if their surfaces are smooth or if the ureter has been previously dilated, frequently pass along the ureter to the bladder without causing any trouble. On the other hand, their passage is in some cases attended by the most severe suffering, and the impaction of a stone so small as to weigh less than two grains may completely destroy the kidney (Fig. 167), or excite symptoms of the most violent character, ending even in fatal collapse. If the stone reaches the bladder all distress ceases, at any rate for a time, and it either remains

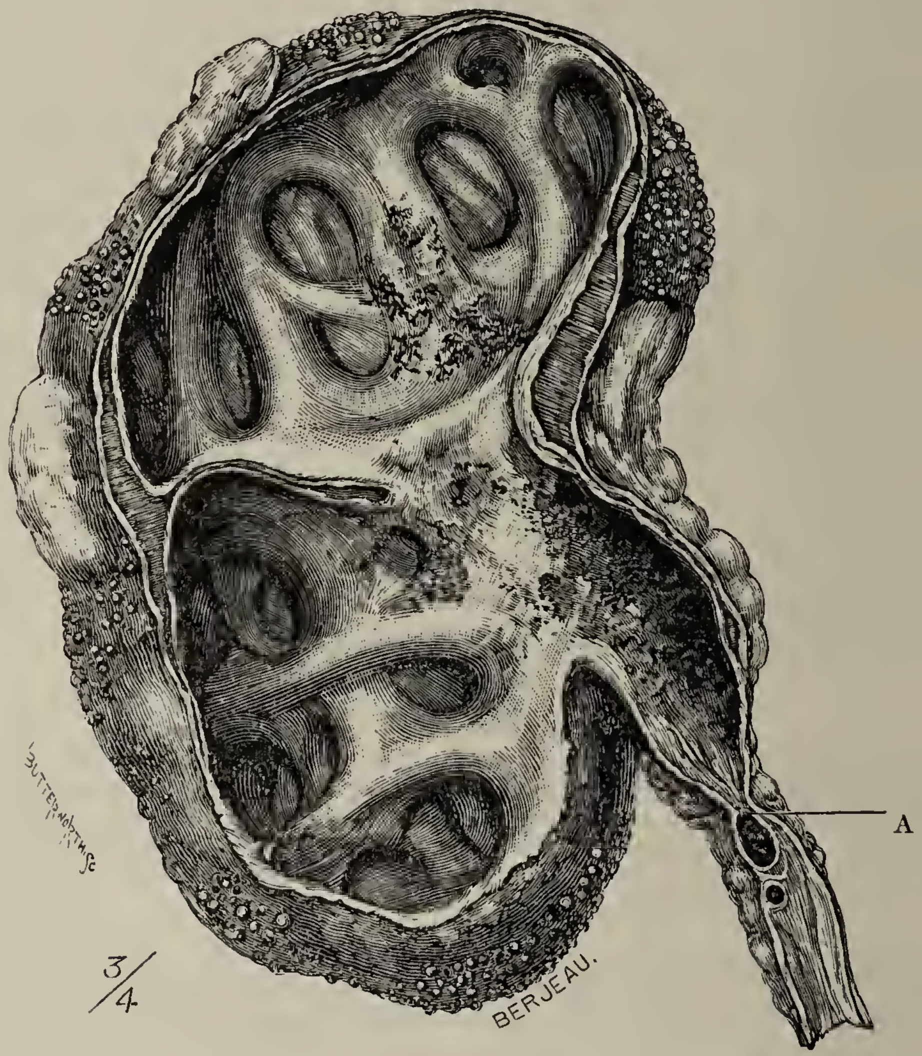

Fig. 167.—Pyo-nephrotic Kidney, due to Calculi of minute size blocking the upper end of the Ureter. Removed during life from a female aged 42. (Author's case.)

A, Calculus, with a still smaller one below, impacted in ureter, and resulting in extreme pyonephrosis.

in the bladder and becomes a nucleus for a larger concretion, or later becomes impacted in the urethra, or, more happily, is discharged out of the body with the urine. In males it is very commonly retained in the bladder or, though far less frequently, in the urethra. In women, if it reaches the bladder it almost always escapes by the urethra, and this explains the great difference in the frequency with which vesical calculus is met with in the two sexes. This difference does not exist in renal and ureteral calculus. Out of forty-seven cases of ureteral calculus referred to in the Table which I published in the *Lancet* (December 16th, 1899) twenty-seven were in females, eighteen were in males, and in two cases the sex is not stated.

Etiology.—Stones in the ureter descend from the kidney, and their impaction is due to their volume or their irregularity of shape and roughness of surface. In the first place, the spasmodic contraction of the muscular coats of the ureter, provoked by their presence, and at a later period the inflammatory swelling and ulceration of the mucous membrane, add to the difficulty of their progress towards the bladder. Should the irritation lead to thickening, rigidity, or stenosis at the seat of impaction the stone will remain permanently fixed.

Calculous concretions formed *primarily in the ureter* are very rare. When they occur they are composed of phosphatic salts deposited above a stricture, or upon an ulcer of the ureter, or upon a foreign body within the ureter, such as a catheter *en demeure.* Boyer mentions a case in which a pin in the ureter became encrusted with salts and gave rise to an abscess.

Duration of impaction.—When a calculus becomes impacted in the ureter it may remain there, if not extracted by the surgeon, for an indefinite time or altogether. It must not, however, be inferred when a stone is discovered in the ureter that it has been there for the whole or the greater part of the time since the onset of the symptoms. It may have been in the kidney for the greater part of the time. With our present knowledge it is impossible in most cases to diagnose between a stone or other cause of obstruction in the renal pelvis and the same condition in the ureter.

Negative explorations of the kidney followed after a time by the discharge *per urethram* of a small calculus afford us some evidence as to the length of time during which a calculus may remain in the ureter before being passed naturally, though this evidence is not precise as to the exact duration of impaction. During the twenty years since my first renal operation I have had six cases in which a stone must have been present in the ureter at the time of the operation, although the kidney was explored with a negative result in each case. Five out of six of these patients subsequently passed a calculus, and one died more than twelve months after the operation, and a stone was found at the post-mortem examination impacted near the vesical end of the ureter on the side which had been explored. In one of the five surviving cases two small calculi were passed during convalescence. In another the right kidney was explored on March 26th, 1890, and a small renal calculus was passed in June, 1891—*i.e.*, after an interval of fifteen months from the exploration. Then followed a period of eighteen months of complete immunity from symptoms, but in January, 1893, the patient was seized with intense pain and hæmaturia and this attack was followed by other similar attacks up to December 6th, 1897, when I again explored the same kidney and removed a large calculus from the renal pelvis and at the same time performed uretero-lithotomy for a small calculus which was completely blocking the ureter at a point about an inch and a half above the brim of the bony pelvis (No. 40 in the list published in the *Lancet*, December 16th, 1899). From the large size of the stone which occupied the renal pelvis it is certain that the stone in the ureter must have been lodged there for many months at least. The kidney was greatly disorganised. In each of the three other cases the kidney was movable; complete exploration was made of the kidney with negative results, and yet a calculus was passed by each patient, attended with pain on the side operated upon, at periods of nine months, thirteen months, and five and a half months respectively after the operation. There is good reason to believe that in each of these three cases the kidney afterwards resumed its function perfectly.

In all these six cases the kidney was taken out upon the loin, inspected, and palpated; in five of them the kidney was opened along its convex border and a most thorough exploration was made with the finger within the organ. It is not possible that the calculus could have been missed had it been in the kidney or infundibulum at the time of exploration. From the continuance of the same symptoms after as before the exploration and the complete and lasting relief which followed the passing of the stone, there is no escape from the conclusion that the stone was impacted in the ureter at the time of the exploration. Some time before the last of these cases occurred I had commenced what is now an invariable rule with me—namely, sounding the ureter in its whole length before completing the operation. In this case I detected an obstruction in the ureter some distance below the brim of the bony pelvis, but for ethical reasons which I thought important at the time, and which I need not here mention, I did not cut down upon the ureter at the seat of the obstruction, though it would have been better if I had done so. After five and a half months, having in the interval suffered repeated attacks of severe pain over this spot, the patient passed a small ovoid calculus (Fig. 168), and he has been quite well ever since.

Fig. 168.—Calculus impacted in the Pelvic Portion of the Ureter at the time of the nephrotomy and subsequently passed naturally. (Author's case.)

Facts of this kind inform us that a calculus may remain in the ureter for a long time and after escaping may, as we know from the results of various experiments and from abundant clinical experience, leave the obstructed kidney still capable of discharging its functions provided the obstruction has not been complete, or, if complete, has not been prolonged beyond a few months.

Position of impaction.—It is a matter of great importance from a surgical point of view to know at what points in the ureter impaction occurs. In the normal ureter the smallest diameters are found, first at a point about five or seven centimetres (from two to two and a half inches) from the hilum of the kidney, and one or two centimetres below the commencement of the ureter; secondly, where the ureter enters the wall of the bladder, and especially at its termination on the mucous surface of the bladder; and thirdly, there is another but a slighter narrowing (in three out of five subjects) where the ureter *crosses the brim* of the bony pelvis. It is at one or other of these points that calculi are more usually arrested, but they may become lodged at other points (Fig. 169).

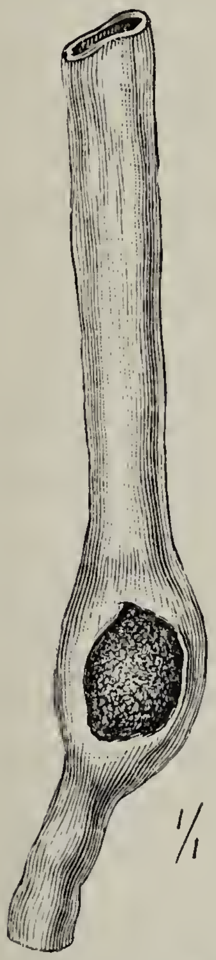

Fig. 169.—Oval Calculus impacted in the Ureter three inches below the Renal Pelvis, which was dilated. Renal substance was normal. (Westminster Hospital Museum, No. 833.)

In some of the recorded cases of uretero-lithotomy the calculus has been found impacted a little below the brim of the pelvis.

This is a portion of the ureter which is comparatively wide and has a slight fusiform dilatation, and therefore a stone which has traversed the upper aperture might be expected not to lodge here. The explanation of its doing so is no doubt to be found in the curved direction rather than in the size of the tube at this part of its course.

Position of impaction as found in post-mortem examinations.—In the fifty volumes of the *Transactions* of the Pathological Society of London there are twelve cases recorded of impacted ureteral calculus; in five, one or more calculi were lodged at the lower end of one ureter and one or more calculi were found also in the opposite kidney. Anuria occurred in each of these cases. In three a calculus was impacted at the upper end; in one of these cases the kidney of the involved ureter was misplaced and malformed.* In two cases both ureters were obstructed by calculi near the vesical orifice; and in another a calculus was impacted in the left ureter one inch from the bladder. In each of these three cases death was caused by uræmia. In the twelfth case the lower opening of the right ureter was entirely obliterated and three calculi were lodged in separate compartments of the duct, formed one above the other by constricting bands on its inner wall; the largest stone was situated in the upper third o the ureter and was about three inches long and three-quarters of an inch in diameter. In some post-mortem cases the ureter has been found filled, or nearly filled, from end to end with calculi (Fig. 170; *see* also p. 149). Wilmot† gives a case of suppurating solitary kidney with a calculus blocking the ureter. Other cases of

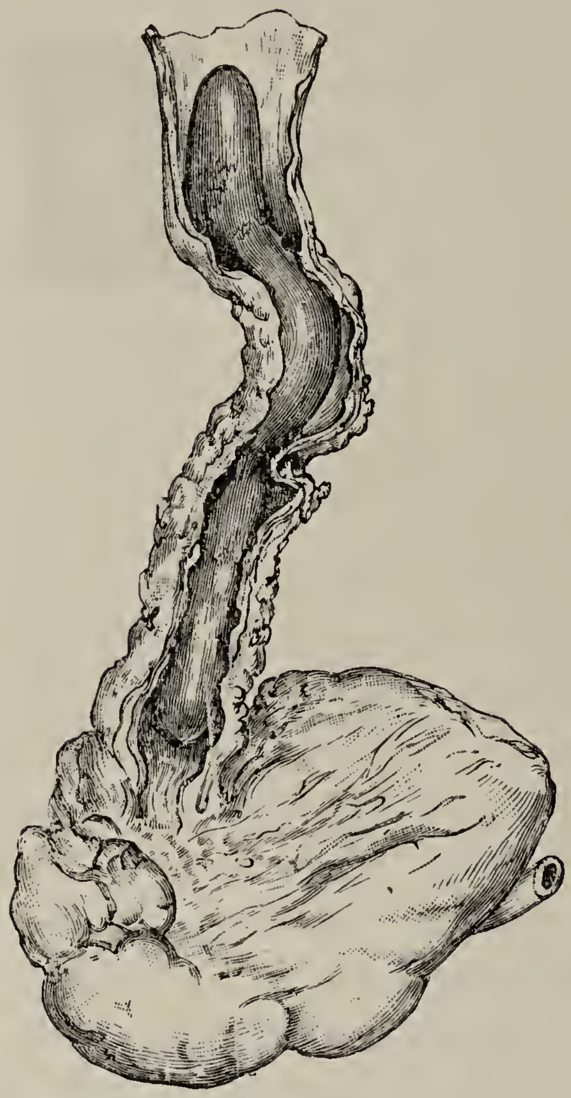

Fig. 170.—The Right Ureter, and a portion of the Bladder and Left Ureter. A Calculus, $5\frac{1}{2}$ inches long, occupies the right ureter, almost filling it. (St. George's Hospital Museum.)

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* *Trans. Path. Soc. Lond.*, vol. xiii., p. 47.

† *Brit. Med. Journ.*, Nov. 24th, 1883.

calculi in misplaced kidneys are mentioned in the section on "Misplaced Kidney" (*see* Part I., Vol. I., p. 24). A horse-shoe kidney with a calculus in each ureter, and a misplaced solitary kidney with a calculus in the dilated renal pelvis, are illustrated respectively on p. 72 and p. 25 (Vol. I.).

Position of impacted calculi found at operations.—I have tabulated forty-six cases in which an operation was completed on account of a calculus impacted in the ureter. The seat of impaction is stated in forty-four of them. In nineteen it was within two inches of the kidney, in fifteen just before or where passing through the vesical wall, and in eleven somewhere about the level of the brim of the true pelvis; in three of the eleven cases the situation of the stone was below the brim, in two on the brim, and in five just above the brim; in the remaining case the description given is, "A stone was found half-way down the ureter." In one case the position of impaction is not stated. In one of my own cases in which a stone was at the upper end a second calculus was impacted four inches lower down.

It is a noticeable fact that twelve out of fifteen cases where the impaction was at the lower end of the ureter occurred in women, and no case has been noted of uretero-lithotomy in the male for stone impacted in this situation. I have not been able to ascertain the sex of Ceci's patient, from whom a calculus was removed through an incision in the wall of the rectum. In Rawdon's case a stone was felt by the rectum in the lower part of the left ureter of a boy close to the bladder orifice, and though not removed by operation was verified by post-mortem examination. In two cases in my table, in which a stone impacted near the bladder led to nephrectomy, the patients were males, one thirty-seven and the other thirty-eight years of age. Spencer Wells reports a case of urinary calculus of the size of a bean which had formed an abscess about the prostate and passed into the rectum direct from the ureter. Agnew relates a case, presumably in a boy, whom he cut for stone in the bladder; the left ureter was enormously dilated and packed with calculi of considerable size, two of which at an interval of three months escaped into the bladder and were removed by vesical lithotomy. Dr. F. W. Gordon of Auckland (New Zealand) sent me notes of a case of sudden death in a man after the introduction of a catheter into the bladder. One kidney was found on post-mortem examination to be enlarged, the other was a small sac weighing only three drachms, and its ureter was obliterated at the vesical extremity, presumably due, as Dr. Gordon considered, to the lodgment of a renal calculus which had ultimately been passed *per urethram*. Besides the cases contained in my collected list published in the *Lancet* in December, 1899, Israel has in three cases removed calculi by ureterotomy. Two of the operations were by the vaginal route. Newman has lately published three cases in which he removed calculi impacted in the vesical portion of the ureter: one, in a female, by dilating the urethra, and two in males by supra-pubic cystotomy. Bishop has removed a calculus impacted in the vesical orifice of the ureter in three cases by supra-pubic cystotomy. I have operated lately on three females for ureteral calculus—in one by the retro-peritoneal lumbo-iliac route; and in two by the sacral route. In one of the latter I removed the ureter, and in it were nine calculi. Israel also speaks of two cases in which he has removed the ureter entirely filled with stones.*

Characters of ureteral calculi.—As we should expect, remembering their origin in the kidney, ureteral calculi differ in size, form, and composition. Some are composed of uric acid and others of the urates; others, again, of calcium oxalate or phosphates. They vary much in volume and number. Fig. 126 (p. 149) shows both ureters from the same individual packed with smooth calculi. Sometimes a calculus forms a mould of a great part of the duct, as in a case referred to by Le Dran, and in a specimen in St. George's Hospital, London, which is illustrated on p. 450.

From one patient, to whom I have previously referred, I removed nine calculi from the lower part of the ureter, in which they moved about like marbles in a cylinder.

Roberts ("Urinary and Renal Diseases") relates a case in which a single stone like a hemp-seed, weighing one grain and a third, and another in which a round uric acid stone of the size of a small pea and weighing one grain and a half, killed their victims. Usually their size does not exceed that of a cherry-stone, a horse-bean, or a date-stone. They are often ovoid and elongated but sometimes more nearly spherical. Those which are prolonged into the ureter from the renal pelvis are sometimes hammer-shaped. If other calculi have been or are in the renal pelvis, the one blocking the ureter may be angular or faceted (Fig. 171). They may be faceted if two or more are lodged in contact with one another in the ureter itself (Fig. 172). If they remain long in the ureter they may increase by superposition of fresh salts from the urine both at their extremities and upon their surface. Their surface is smooth and even polished if of uric acid or the urates, rough and often sparkling with clear beautiful crystals if of phosphate of lime, and minutely but roughly tuberculated or covered with sharp amber-coloured or brownish or yellowish-black points if of calcium oxalate. I have operated on a case where a small rough calculus of calcium oxalate was actually fixed by its processes in the walls of the ureter and required to be dug out before it could be removed (*see* p. 461). Some rough-surfaced phosphatic calculi may be as firmly fixed. The other varieties of stone, though they may be tightly compressed by the ureteral walls, are not adherent to them. Urine may travel past the calculus and make a gutter-like depression on its surface when the ureter does not tightly invest it. Le Dran quotes a case in which there were several calculi, weighing together 3 ounces, impacted in the middle part of a ureter, yet urine found its way along the duct between and beside the stones. Some calculi move like a ball-valve from the renal pelvis into the ureter and back again. Others when they have reached the lower end may project through the ureteral orifice into the bladder. In some instances instead of a definite calculus there has been found a soft mortar-like calculous mass.

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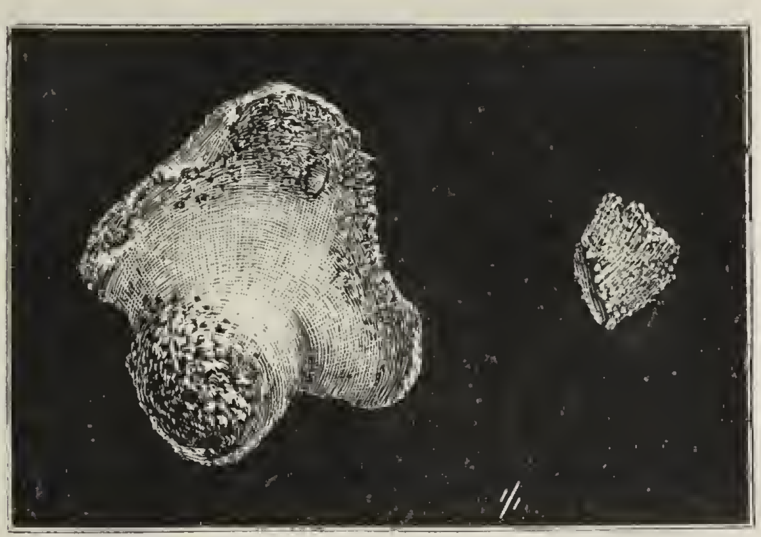
* *Berl. Woch.*, Feb. 27th, 1899.



171.—The larger Calculus was removed during life from the Renal Pelvis; the smaller one (alsoduring life) from the Ureter $4\frac{1}{2}$ inches below the Renal Pelvis. (Author's case.)

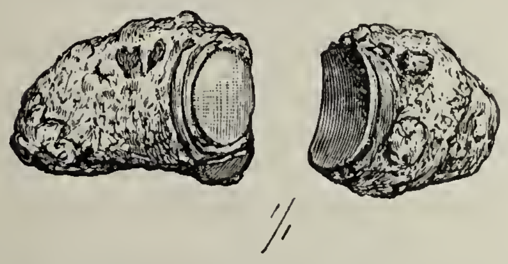


Fig 172. — Two Calculi with Facets which were impacted in the Ureter against one another. (Westminster Hospital Museum, No. 836.)

Diagnosis.—Unless a calculus in the ureter can be felt through the abdominal parietes, the rectum, the vagina, or the bladder, its precise location cannot be ascertained except by an exploratory operation.

In most of the cases in which the stone has been impacted near the renal end of the ureter it has been discovered by a digital examination at the time of exploring the kidney, and generally when no stone has been present in the kidney itself. In one of my cases a stone was ascertained to be lodged in the ureter about one and a half inches above the brim of the bony pelvis by probing the ureter immediately after a large stone had been extracted from the kidney (No. 40 in the *Lancet* list). It was removed by prolonging the lumbar incision downwards and forwards towards the groin and exposing the ureter at the site at which the ureteral bougie met with a complete obstruction. These cases afford a striking illustration of the value and importance of sounding the ureter throughout its extent before concluding an operation, even when one or more calculi have been found and removed from the kidney. In another case I operated upon very recently, the kidney of a woman aged twenty-seven was explored with a negative result, but by probing the ureter a calculus was detected and removed from the duct just above where it entered the broad ligament of the uterus.

The intra-peritoneal exploration has revealed the presence of a calculus in the ureter in a few cases and has been adopted for very different reasons in each. Thus in Cullingworth's case the calculi were felt *per vaginam* and mistaken for diseased ovaries; in Lane's case the kidney had been explored from the loin some months before without result so far as finding a stone or relieving the symptoms; and in Hall's case, though the symptoms pointed to the kidney as much as to the ureter as being the seat of the calculus, an exploratory laparotomy was performed as a preliminary diagnostic precaution. Hall's order of procedure is not to be recommended. In a word, when the symptoms clearly indicate the *side* to attack and there is no indication by rectal examination in the male or vaginal examination in the female that the stone is impacted in the lower end of the ureter, or by palpating the abdomen that it is on the brim of the bony pelvis, renal exploration and sounding the ureter through the loin is the proper course to follow. The ureter can be afterwards exposed lower down, if need be, by prolonging the incision in the lumbo-ilio-inguinal line.

From calculus in the kidney.—When it is remembered how uncertain and inconstant the symptoms of stone in the kidney may be, and in how many cases they are not referred to the kidney at all but to some point along the course of the ureter or to the bladder, the ovary, the testicle, or to some other organ altogether, a correct diagnosis of stone in the ureter is not to be frequently expected. Moreover, in many cases of ureteral calculus there are other calculi present in the renal pelvis or calyces. The symptoms produced by a calculus impacted in the ureter simulate those of a stone in the kidney itself, so that in nine out of eleven cases of uretero-lithotomy an operation was undertaken under the conviction of finding a stone in the kidney. The converse is equally true, that the symptoms caused by renal calculus simulate those of impacted ureteral calculus. The seat of pain and the point of greatest tenderness on pressure in some cases of stone in the kidney are in the course of the ureter and not just below the eleventh or twelfth rib in front, or at the outer edge of the erector spinæ mass behind, as classically they should be. Lumbar exploration alone can clear up the diagnosis.

When the stone is situated high up in the ureter near the renal pelvis it is impossible by clinical symptoms to decide whether it is in the kidney or in the ureter until it has been detected by palpation through the lumbar wound; but this is of no moment because it is impossible without exposing the lower part of the kidney to remove a calculus from this part of the duct by the extra-peritoneal method. The intra-peritoneal operation in such cases is to be absolutely condemned.

When the stone is impacted lower down its exact position can be ascertained by the ureteral bougie passed through an opening in the renal pelvis, and if one be found within the lower abdominal or upper pelvic part of the ureter in the female or in any part of its lower course in the male, the calculus can be removed by the extra-peritoneal method after prolonging the lumbar incision forwards and downwards.

When in the female the stone is impacted below where the ureter leaves the pelvic wall, but still at a distance of from two and a half to three inches from the bladder, its position can be diagnosed by vaginal digital examination, though the best way to extract it is by the sacral route. I have succeeded by this method in two very interesting and important cases. Ureteral catheterisation upwards from the bladder has been recommended, but though this may detect an obstruction and localise its situation it cannot always differentiate stone from stricture of the ureter.

From encysted vesical calculus.—In an article on calculus impacted in the ureter published in 1884 * I stated: "It is quite an ancient question in diagnosis whether some of the cases of encysted vesical calculus are not really instances of renal calculus impacted in the lower end of the ureter. It was a subject of discussion in the time of Abraham Vater and Littré (1702); and Morgagni, Collet, Le Dran, Desault, Deschamps, and Charles Monod have since taken part in it."

Calculi which have reached the vesical end of the ureter, failing to enter the cavity of the bladder, may become propelled through the side of the ureter and between the coats of the bladder towards the urethral opening; and thus, endeavouring to make a new passage for themselves, may form a sac beneath the mucous membrane of the bladder. Such a sac may present at a spot some little distance from the mouth of the ureter, and may or may not ultimately ulcerate or rupture into the bladder cavity. This sac might either have a channel opening into the lowest part of the ureter (as seen by Littré), or the passage from the ureter to the sac might become shut off by adhesions; in either case it will be completely closed towards the bladder unless the mucous membrane has ulcerated or ruptured over the calculus. It is, of course, possible that such a shut sac, like a prolapsed ureter, might form a pendulous vesical tumour. The diagnosis between a stone impacted in the lower end of the ureter and one encysted in a sac formed in the manner just described, or encysted in an ordinary sacculus of the bladder, might in some instances be made by observing the position of the swelling. A stone impacted in the lower extremity of the ureter may be partly projecting at the ureteral orifice, but if not it will have the direction and situation of the intra-mural section of the ureter. A stone contained within a sac formed by the bulging or rupture of the ureteral wall and the separation of the coats of the bladder will have a situation between the mouth of the ureter and the urethral opening of the bladder. A stone encysted in an ordinary vesical sacculus may be situated at any part of the bladder—the lower, the middle, or the upper part. The ureteral orifice with the stone impacted behind it might become obliterated, just as the orifice of a common sacculus of the bladder in which a calculus is lodged may be.

If the ureteral orifice became closed it might be impossible to distinguish on palpating or inspecting the bladder a calculus impacted in the ureter from one enclosed within a sac formed by a pouch of the ureter and propelled between the coats of the bladder. In neither case would an aperture of any kind be seen or felt, and if the sac were laid open there would be found in both cases an epithelial lining on the inner or ureteral, as well as on the outer or vesical, surface; in either case the outstretched ureteral wall might be so compressed against the lining membrane of the bladder as to make them appear like a single structure. If the ureteral wall had ulcerated before the calculus was propelled beneath the bladder mucous coat, the inner wall of the sac would be deficient in an epithelial lining.

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* *Amer. Journ. Med. Sci.*, October, 1884, p. 464 *et seq.*

No differential diagnosis between the two classes of cases can be made clinically. The presence of nephrectasis * is not characteristic of the one as distinct from the other. If obstruction by an impacted ureteral calculus has been complete from the first, the kidney atrophies; if on the other hand the obstruction is partial and continuous, the kidney may be very little altered; whereas if the obstruction is incomplete with occasional intermissions of complete obstruction, renal dilatation with atrophy of the parenchyma is produced. A considerable degree of nephrectasis may exist without giving rise to a swelling which can be detected at the bedside.

It is the same with a calculus in a closed pouch of the ureter and with a calculus in an ordinary vesical sacculus, if near the ureteral orifice. Either may cause complete or only partial obstruction throughout, or incomplete obstruction with intermissions of complete obstruction. Suppurative pyelitis is much more likely to occur in "ureteral sac" cases, because urine getting from the ureter into the sac would lead to decomposition, and this to ascending ureteritis extending to the kidney. The occasional intermittent discharge of large quantities of pus with the urine has been caused in this way.

From cystitis.—In so many cases of renal and ureteral calculus the leading symptoms, and very frequently the only symptoms, have reference to the bladder; consequently the patients are often treated for cystitis. This deplorable error would not so often be made if more attention were given to the examination of the urine, and especially to its effect upon litmus paper. With calculus in the kidney or ureter the urine is more or less acid; even when it contains a large quantity of blood or pus it is as a rule still slightly acid. The pyuria of pyelitis or pyelo-nephritis produces a uniform turbidity, and the turbidity continues even after the urine has had time to deposit, showing that much pus remains diffused throughout its volume; moreover, there is an absence of any marked quantity of mucus. With cystitis the degree of pyuria also varies extremely, but the pus is most abundant at the beginning and ending of micturition, indicating that its source is the mucous membrane of the bladder. The urine is alkaline, deposits a large quantity of stringy mucus, is offensive, and often has a strong ammoniacal odour when or soon after it is voided.

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* I have suggested and have used this term to embrace every form of distension of the renal cavity, whether with urine, pus, or blood. It therefore embraces hydro-nephrosis, pyo-nephrosis, and hæmato-nephrosis.

A calculus impacted at the vesical orifice of the ureter, especially if it projects into the bladder, may give rise to cystitis; but in this case sounding the bladder, digital examination by the rectum or the vagina of the lower end of the ureter, and bimanual examination of the empty bladder under an anæsthetic will enable the surgeon to make out the presence and situation of the impacted stone. In several of the cases in my list the calculus was felt by vaginal examination.

From ureteritis.—When the irritation caused by a calculus in the ureter is chronic, inflammation of the ureteral walls is likely to supervene. There is nothing to distinguish calculous ureteritis from other forms of inflammation of the ureter, except the tuberculous. The mode of onset, the history of renal colic, and possibly the former passing of calculi indicate stone, but are not absolutely characteristic. A ureter involved in its whole length either by tuberculous or simple inflammation usually has its tenderest point at the brim of the bony pelvis, and if there is here a considerable induration of the peri-ureteral tissue, as there often is in chronic ureteritis from any cause, it may form a nodule or lump which is very liable to be mistaken for a calculus. In tuberculous ureteritis tubercle bacilli may be found in the urine.

From the early stage of vesical tuberculosis.—The urine in vesical tuberculosis before the disease has reached the stage of tuberculous cystitis is clear and pale except when tinged with blood. With increased frequency of micturition there is often increase in the quantity of urine, which may amount to three or four pints in twenty-four hours. Tubercle bacilli will most likely be discovered in this clear urine by the microscope and by cultivation experiments. When cystitis supervenes the urine will contain pus and mucus. The pus may be flocculent and slight in amount and be contained chiefly in the urine first passed, not uniformly diffused throughout the whole quantity voided, as it is when derived from the ureter or renal pelvis. The tubercle bacilli are not often found in purulent urine. The hæmaturia of tuberculosis is at first so slight as to escape notice, or it makes the urine faintly pink or rose-tinted throughout, though there may be a few drops of pure blood at the end of micturition. It is spontaneous, coming and going without obvious cause. Hæmaturia and pain are sometimes increased by movement and standing but are not relieved by rest and the horizontal posture, as the hæmaturia and pain caused by calculus generally are; indeed, in tuberculosis the symptoms are often aggravated at night and by the recumbent position.

From prolapsed and adherent ovary.—There are at least two instances on record where a calculus impacted in the lower end of the ureter has been mistaken and operated upon for a prolapsed, tender, and adherent ovary. It may be well, therefore, to point out some of the characteristics by which the two conditions may usually be distinguished, and I am indebted to Dr. Cullingworth for his assistance in doing so. A calculus lodged in the terminal portion of the ureter would be felt through the lateral fornix of the vagina, or through the antero-lateral vaginal wall below the level of the cervix uteri, as a hard, oblong body, lying sufficiently loosely in the cellular tissue to have a fair amount of mobility and with its long axis corresponding with the direction of the ureter. A prolapsed and adherent ovary, on the other hand, would be situated within the peritoneal cavity, either in Douglas's pouch (where the question of its being a calculus in the ureter could not arise) or lying on the floor of the fossa behind one of the broad ligaments. In the latter case it would have a greater thickness of tissue between it and the examining finger than would a calculus in the ureter. Moreover, an ovary would never be found on the outer side of the antero-lateral wall of the vagina, or anywhere below or in front of the cervix uteri. Other differential characters would be found in the greater hardness and distinct mobility of the calculus, in the direction of its long axis, and in the fact of there almost invariably being, in the case of a prolapsed and adherent ovary, other evidences of old pelvic peritonitis. The condition perhaps most in danger of imposing upon the unwary is where an adherent and prolapsed ovary is lying on a hard and thickened pelvic floor after an attack of severe pelvic peritonitis. The fixed and diffuse character of the hardness as contrasted with the well-defined, intensely hard, and strictly localised swelling caused by the presence of a calculus serves, however, clearly to distinguish it. If by any chance a calculus became impacted a little higher in the ureter—that is, before it is crossed by the uterine artery—it might possibly, especially if on the left side, be felt through the rectum. Its shape, the direction of its long axis, its clearly defined outline, its relation to the iliac vessels, and its "stony" hardness would again be the chief means of distinguishing it from a displaced and adherent ovary.

Symptoms.—The symptoms are the same as those of renal calculus; and as with a stone in the kidney, so also with one in the ureter, it may be either unsuspected or quiescent, no symptom whatever may cause its presence to be known during life, and its discovery may be a surprise on post-mortem examination; or it may excite symptoms which point to some other part or organ, not to the ureter; or after causing more or less severe disturbance it may settle down and become quiescent for years.

In thin persons, when the stone has been impacted just above the brim of the bony pelvis a small hard body has in rare cases been felt through the abdominal wall. If in the presence of the ordinary symptoms of stone in the kidney the position of such a lump corresponds with the seat of a constant pain and of a pricking sensation whenever pressure is made upon it, the localisation of a stone in the ureter is pretty clear. So is it if, with the symptoms of stone in the kidney, or with frequent and painful micturition, a hard body is felt in the course of the ureter by vaginal or rectal palpation, or by digital examination or sounding of the bladder. On cystoscopic examination the mucous membrane around the ureteral orifice may be seen discoloured from extravasated blood when a calculus is impacted at the lower end of the ureter.

Through the roof of the vagina a calculus can be felt at any spot within the last two and a half or three inches of the ureter and could be removed therefrom without opening the peritoneum. Through the rectum not more than one inch and a half of the ureter is thus under control. In Rawdon's case the calculous mass felt through the rectum gave the impression of being fixed to the posterior wall of the bladder. The lower end of the ureter contained a cretaceous substance and two calculi; the lower calculus was of the size of a date-stone and was close behind the ureteral orifice.

The passage of a calculus along the ureter should be suspected if attacks of pain and hæmaturia and other symptoms suggestive of renal calculus have extended over several days or weeks or months, and if with each succeeding attack the pain and tenderness on pressure are located lower and lower down along the course of the ureter, and the bladder at length becomes the seat of pain and irritability. So also should suspicion be aroused if, after one or more attacks of typical renal colic, the patient is suddenly seized, after walking or some exertion, with a violent pain shooting along the course of the ureter, and especially if this is followed by settled pain and great tenderness at one particular spot in the course of the duct, lasting days or weeks uninterruptedly. I have related a very typical case of this kind in my "Hunterian Lectures" on the "Origin and Progress of Renal Surgery" (1898, p. 77).

The severity of the pain and hæmaturia and the subsequent effect upon the kidney depend upon the character of the stone more perhaps than upon its size. A small calculus with a rough or angular surface does the greatest harm and is less likely to pass than a smooth uric acid calculus of much larger size; it is more prone to stick into the wall of the ureter and cause œdema, inflammation, or ulceration. Fig. 173 shows the natural size of a minute calculus which I removed from the ureter of a lady two inches below its junction with the renal pelvis. It had given rise to six months of continuous discomfort, aggravated by the most severe attacks of pain and hæmaturia. Rest gave relief, but on one occasion after a period of three weeks in bed the first walk across the bedroom induced a fresh attack of great severity. The calculus was very firmly fixed by its minute rough processes and had to be actually dug out of the ureteral wall. In this case hæmaturia was a very pronounced symptom.

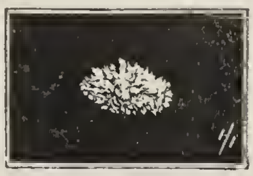

Fig. 173.—Calculus removed during life from the Ureter two inches below the Renal Pelvis. (Author's case.)

As soon as impaction occurs in the ureter the symptoms will greatly depend upon whether or not the opposite kidney is healthy in structure and unhampered in function. If there is but one kidney or the two kidneys are fused and have only a single ureter; if the opposite kidney has been previously destroyed, whether by calculous, tuberculous, or some other disease; or if the two ureters are blocked simultaneously by calculi, anuria with all its alarming symptoms is the result (*see* chapter on Calculous Anuria, Part I., Vol. II., p. 145).

A calculus of one grain and a half impacted in the ureter has been the cause of a fatal anuria under such conditions as those just mentioned. If the calculus is dislodged under the influence of accumulated pressure of urine, of opium or chloroform, or of the expulsive power of the ureter, the kidney may regain its secreting function and the effects of anuria may pass off. On the other hand, the poisoning effects of uræmia may be too severe to pass off with the escape of the stone, and death may result just as if the calculus had remained impacted. It is often stated that anuria is in some instances produced by a calculus, lodged in one ureter, causing a reflex suppression—*i.e.* producing a complete inhibitory effect upon the opposite kidney. It is doubtful, however, whether such an effect, if it ever occurs, lasts more than a few hours when the opposite kidney is structurally quite healthy.

A persistent abdominal tumour on the same side as the impaction, due to nephrectasis, is an occasional symptom of ureteral calculus.

An intermittent abdominal tumour due to hydro-nephrosis—*i.e.* a tumour attended commonly by great pain and preceded by a diminution in the quantity of urine passed, and the subsidence of which is accompanied and followed by the relief of pain and by a largely increased discharge of urine—has for some years past been regarded as a recognised symptom of renal obstruction due to calculus, movable kidney, ureteral valve, or ureteral stricture.

Nephrectasis is very apt to occur in those cases in which the calculus is in the upper end of the ureter and from time to time slips back again into the dilated renal pelvis. It must not be forgotten, however, that very considerable atrophy of the renal parenchyma with considerable dilatation of the renal pelvis and calyces (nephrectasis) is often present without any evidence of a tumour ascertainable by palpation of the abdomen. Another indication of hydro-nephrosis, whether associated with an abdominal tumour or not, are the symptoms of intermittent renal distension just described.

Periodical discharges of pus point to intermittent pyo-nephrosis. The late Dr. Habershon* recorded a typical case of this kind. A man, aged sixty-four years at the time of his death, had from the age of sixteen years suffered from periodical discharges of pus. Each discharge was preceded by the formation of a large right-sided abdominal swelling and was followed by the disappearance of the swelling. After death a calculus was found blocked in the right ureter, and several pints of pus distended the pelvis of the right kidney, the upper part of which was the seat of a cancerous new growth.

The urine may contain some or other of the following deposits—crystals, fragments of calculus, fibrous coagula, blood, blood-casts of the ureter, and pus. In some cases blood and pus have been found together in small or moderate amounts; in others there has been severe hæmaturia; and in others, generally cases of long standing, there have been large discharges of pus.

Prolapse of the ureter into the cavity of the bladder, and in the female even through the urethral orifice as far as the vulva, is one of the rarer effects of calculus impacted in the ureter.† Its presence should at once suggest the probability of ureteral calculus.

Prognosis.—1. *As regards the kidney.*—This is very unfavourable. If the obstruction is complete and the ureter remains blocked either by the calculus itself or by a stricture caused by the cicatrisation of an ulcer or slough due to the damage wrought by the calculus while impacted, the kidney after many months becomes converted into a small fibrous mass or small sac. If the calculus after a while, even after four or five months, should be dislodged and the ureteral channel opened up again, the kidney, though damaged, may become repaired.

If the obstruction is not complete, dilatation with atrophy of the renal substance is sooner or later the consequence in most instances, and if any septic condition of the urinary organs arises, pyo-nephrosis and suppurative pyelo-nephritis supervene. Cancer of the obstructed kidney has been met with associated with impacted ureteral calculus of many years' standing (Habershon, Morris).

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* *Transactions* of the Clinical Society of London, vol. xiii., p. 141.

† See *Transactions* of the Pathological Society of London, vol. xiv., p. 185 (Fig. 127); also a case recorded by Davies-Colley, *Ibid.*, vol. xxx., p. 310.

2. *As regards life.*—This depends on the condition of the opposite kidney. If healthy, the unobstructed kidney will become hypertrophied and will perform the additional function demanded of it in a manner consistent with excellent and prolonged life; and if the kidney involved simply atrophies, all may go well with the patient if he does not subsequently form a fresh calculus in the healthy kidney, as in many instances is the case. If, on the other hand, the kidney involved undergoes active inflammatory and suppurative changes, life is jeopardised thereby, and the prognosis then depends upon the promptitude of surgical treatment and the resisting and reparative powers of the patient. If the ureteral wall has been much damaged by the prolonged pressure or laceration caused by the calculus, extravasation of urine may occur into the retro-peritoneal cellular tissue and abscess or diffused suppuration may result.* If the opposite kidney is defective, obstructed, or absent, complete suppression of urine is the consequence of ureteral impaction, the patient becomes comatose and dies within some days or a few weeks from the date of impaction (*see* chapter on Calculous Anuria, p. 145, Vol. II.). If the loss of the function of both kidneys is not quite complete the patient may survive a little longer, pass daily small quantities of urine mingled with blood and perhaps pus, become very ill with fever and diarrhœa, and die in a typhoid state at the end of several weeks (Bence Jones).

Pathological effects.—*On the ureter.*—*Above the obstruction* the ureter may become thinned out by eccentric pressure and stretching, or œdematous, inflamed, or ulcerated, or it may be dilated and sacculated and more or less tortuous. The dilated ureter may rupture,† bursting as the urethra bursts behind a stricture; but usually the ureter becomes thickened as well as dilated from ureteritis. Stricture of the ureter may follow ulceration or a slough *at the site of impaction*. *Below the obstruction* the ureter may be very little, if at all, changed; or part or the whole length of it to the bladder may be thickened and stenosed or converted into a mere fibrous cord. The whole ureter has been met with converted into an impervious cord when a stone had blocked the upper end. The mucous membrane of the bladder around the ureteral orifice is sometimes greatly discoloured from extravasated blood when the ureter is plugged by a calculus at its lower end. A stone impacted in the lower extremity of the ureter may escape into the bladder by setting up ulceration; or after pouching or rupturing the inter-vesical ureteral wall it may cause the mucous membrane of the bladder to project in a cyst-like and more or less pendulous manner; or the lower end of the ureter, whether or not containing the calculus, may be prolapsed into the bladder with the ureteral orifice reduced to the size of a pin-hole and situated on the summit of the prolapsed swelling.

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* *See* case recorded in my "Hunterian Lectures," p. 77.

† Morgagni and Velpeau's "Surgery," 1851, p. 1021. See *Transactions of the Pathological Society of London*, vol. xvi., p. 1761. *See* also St. Bartholomew's Museum, No. 2356.

The calculus is less likely to ulcerate or rupture into the cellular tissue behind the bladder because of the greater thickness of the bladder wall on the outer than on the inner aspect of the ureter. For three-quarters of an inch the ureter traverses the bladder wall, having the muscular coat on the outside and little more than the mucous membrane on the inside of it. As stated previously, Spencer Wells met with a case in which a urinary calculus was dislodged *per rectum* after a periprostatic abscess, and he conjectured, and no doubt rightly, that perhaps the calculus had never been in the bladder but had passed from the ureter backwards.* Cancer of the lower end of the ureter extending to the bladder has supervened on impaction of a calcium oxalate stone in the lower end of the ureter.†

On the kidney.—If the obstruction is sudden and complete, the kidney becomes atrophied without the previous formation of hydro-nephrosis; if, on the other hand, the obstruction is incomplete or intermittent, various stages of hydro-nephrosis and its accompanying changes will be found. The organ may be rendered anæmic, œdematous, and enfeebled, and converted into a shrivelled mass of fibrous tissue; or become polycystic (Fig. 104, p. 654, Vol. I.); or be entirely destroyed and reduced to an aggregation of pouches (Fig. 167, p. 446) with no true renal tissue left; or converted into a thin-walled sacculus containing limpid urine without pus or micro-organisms; or into a thick-walled cyst with thick, tough fibrous partitions (Fig. 124, p. 140), containing many ounces, even a pint or two, of pus and with little or no remains of proper secreting tissue. There is sometimes great thickening as well as dilatation of the renal pelvis and calyces; and with atrophy of the secreting structure there may be great thickening of the fibrous capsule and great increase in the interstitial tissue of the kidney, so that the organ appears to be hypertrophied as well as sacculated. The interior may be filled with pus, dense walls of tough fibrous tissue separating the calyces and sometimes shutting one or more entirely off from the rest—in fact, the kidney may be in any stage of hydro- or pyo-nephrosis. When occupied by a large abscess or distended by pyo-nephrosis, a fistulous communication may form with the surface in the loin or groin (Fig. 175); or may pass through the diaphragm and establish an empyema; or may open into the colon or stomach; or may cause diffused peri-nephritis and retro-peritoneal suppuration. In the cases which I have met with of impacted ureteral calculus where

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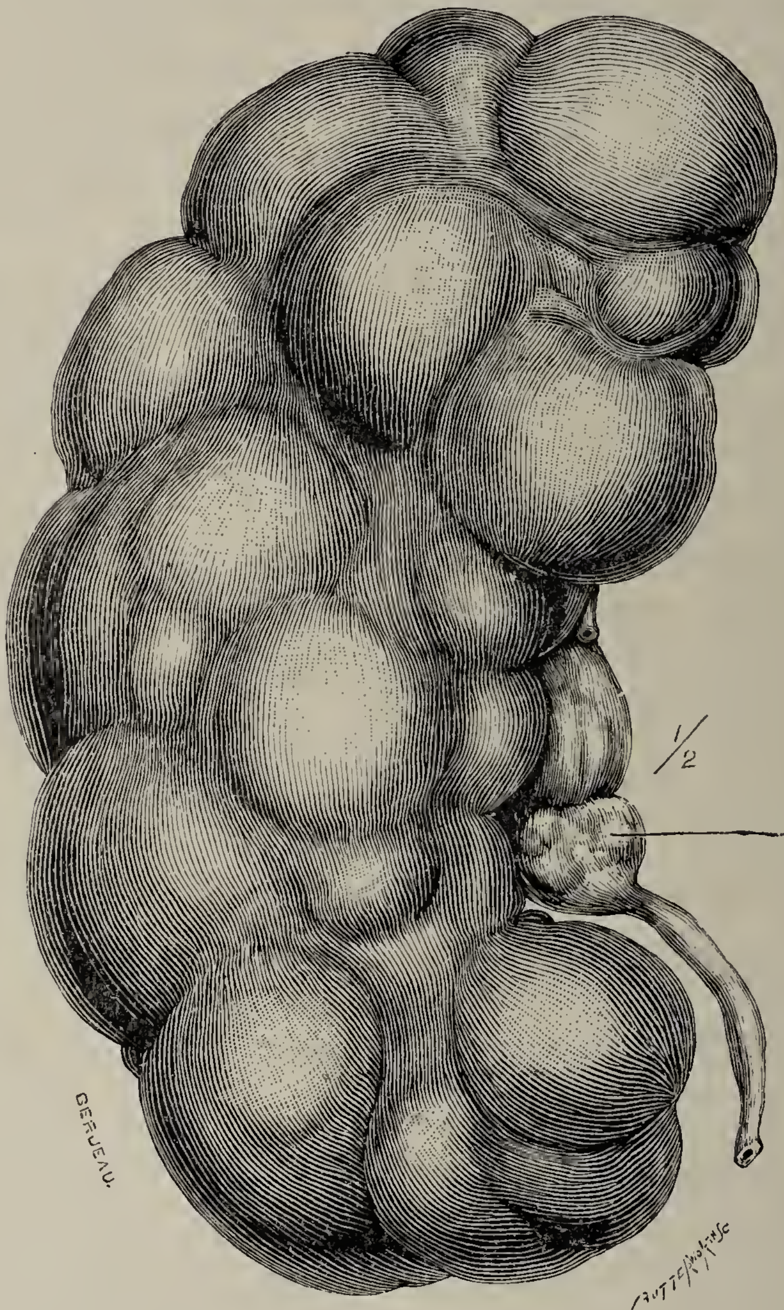
* *Transactions* of the Pathological Society of London, vol. v., p. 202.

† *Brit. Med. Journ.*, October 18th, 1884, p. 758.



Renal Pelvis distended by a Calculus.

Fig. 174.—Small Ureter, with slight contractions of its Lumen. A stone plugs the infundibulum, and the kidney is completely disorganised and converted into a multilocular pyo-nephrotic sac. Removed by operation, Feb., 1897, from a male aged 34. (Author's case.)

the kidney has thus given way and caused fistula or perinephritis there have been calculi present in the kidney also. The kidney has in rare cases become the seat of carcinoma, as stated before.

On the peri-ureteral tissue.—This may become the seat of inflammation and even of abscess or diffused suppuration resulting in fistula. The lumbar region, the groin, the cavity of Retzius, and the periprostatic regions have been the situations of abscess or fistula. Fibro-lipomatous changes are frequent.

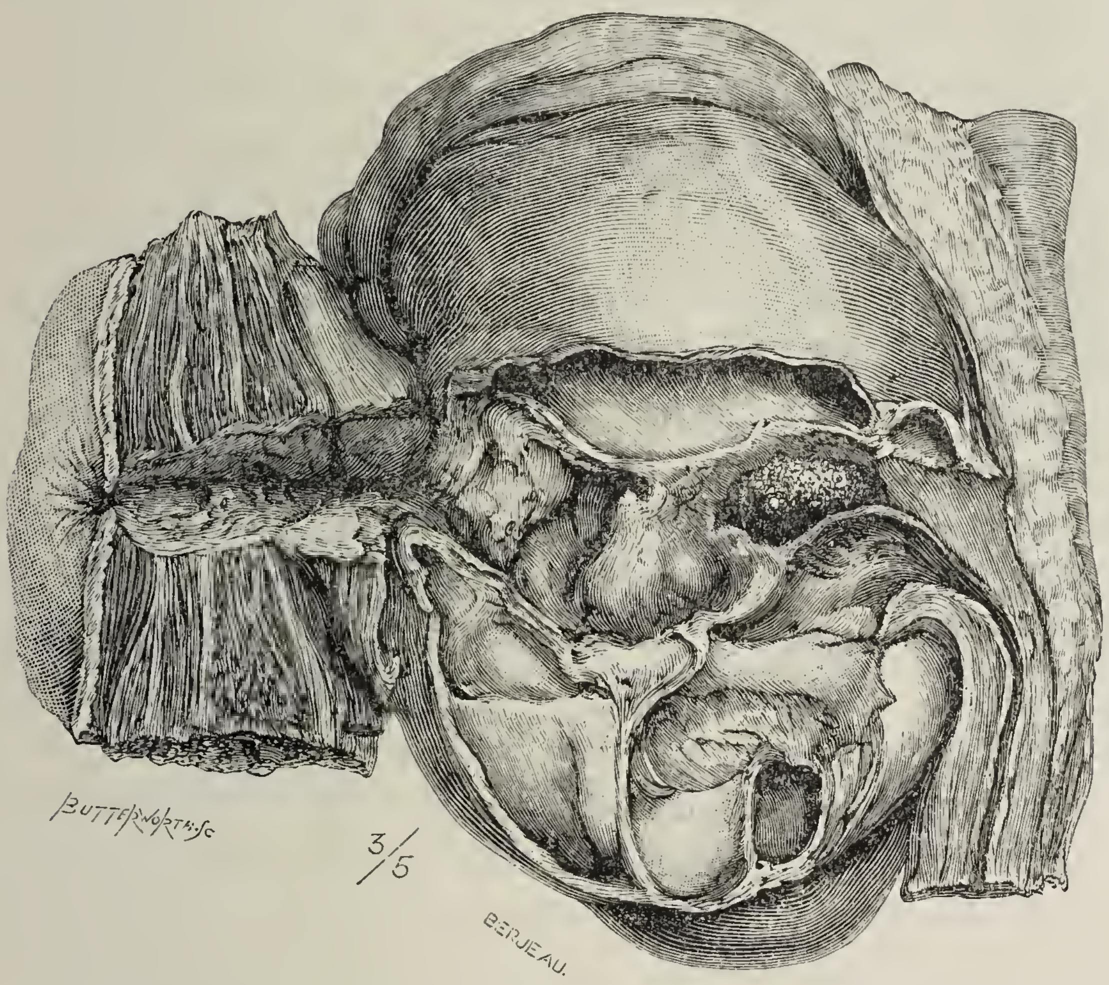


Fig. 175.—Kidney, with Calculus at the beginning of the Ureter, and a Sinus opening at the Loin. The kidney is destroyed, and the ureter thickened by chronic inflammation. (St. Bartholomew's Hospital Museum, No. 2359.)

Treatment.—If symptoms continue to give rise to a suspicion of an impacted ureteral calculus, or if attacks of pain, hæmaturia, and pyuria recur after complete rest and the trial of the usual medicinal treatment, the ureter ought to be examined from end to end by the methods described on p. 139 (Vol. II.). If a calculus is known to be blocking the ureter, it ought to be removed without delay by one of the methods of extra-peritoneal ureterotomy if it cannot be extracted through the renal pelvis. There is no medicinal treatment which is of any use or which affords any hope of saving life or the integrity of the kidney when a stone is impacted in and not simply passing down the ureter.

On the other hand, extra-peritoneal ureterolithotomy is highly successful, and will probably become almost as uniformly so as nephrolithotomy. Velpeau, before 1851, satisfied himself upon the dead body that he might have removed a calculus of the size of a nut through the flank from the abdominal part of the right ureter of a patient under his own care. Gigon of Angoulême in 1856 described every detail of the modern operation of ureterolithotomy which he proposed to perform, but did not carry out, in a case of his own. In justice to myself, and with reference to many remarks which have been made by writers who have had only my article in the *American Journal of Medical Sciences* (published in 1884) before them, I ought to add that in 1885, without then having had the opportunity of carrying it into effect, I recommended ureterolithotomy in any part of the course of the ureter for impacted stone. In a private letter written on September 8th, 1885, to Mr. Albert Dunlop, surgeon-superintendent of the Ipswich Hospital, Queensland (in answer to a letter asking my advice as to a case in which he had explored the kidney of a girl, aged twenty years, with negative result), I wrote: "Either explore the kidney through the loin again and incise the kidney and examine its cavity with the finger and the ureter with a sound, or make an examination of the kidney and ureter from within the peritoneal cavity. If a stone be found in the ureter cut it out from behind the peritoneum and apply continuous sutures to the ureter—if it cannot be pressed downwards into the bladder, whence it can be removed through the urethra. Either of the above should be tried before resorting to nephrectomy."

In a recent article on calculus in the ureter (*Lancet*, December 16th, 1899) I have published in tabular form forty-six collected cases in which an operation had been completed. In but very few of them, however, had an accurate diagnosis been arrived at beforehand. The character of the operations differed greatly. In four cases nephrectomy was performed; in one of these cases, as it proved, the calculus was on the opposite side. In nine cases the operation was nephrotomy, the ureteral calculus having been removed through the incision of the renal substance by pushing it upwards; in some of these cases there was also a stone in the kidney itself. In four cases pyelotomy was performed, the stone being pushed up and removed through the renal pelvis. In twenty-nine cases ureterolithotomy was the method, in four by the trans-peritoneal, in twenty-five by the extra-peritoneal routes. Of the twenty-five extra-peritoneal ureterolithotomies, one was rectal, two were vesical, four vaginal, twelve through a lumbar and six through an iliac or inguinal incision. In the twelve cases of lumbar ureterolithotomies, and in the nephrectomy, nephrotomy, and pyelotomy cases, the operation was undertaken primarily with the object of exploring the kidney. In other words, in twenty-eight out of forty-four cases an operation was performed in the expectation that the disease was renal; in twenty-five of them the calculi were accessible and were removed through the lumbar incision; in three the kidney was so diseased as to lead to nephrectomy. In one of the four nephrectomy cases the abdominal route was chosen as the kidney was hydronephrotic and formed a large abdominal tumour. In one of the nephrectomy cases the calculus was diagnosed through a previous trans-peritoneal exploration. Of the iliac cases diagnosis had been made by laparotomy previously performed in three; in another the position was ascertained by vaginal palpation; in another by catheterising the ureter through the loin, and in the sixth case the kidney had been twice explored through the loin and calculi removed at the first of the operations. It is clear from this analysis that in the great majority of cases a lumbar operation will be the right practice to adopt.

Since this table and analysis was published I have collected twelve and operated upon four more cases, making sixteen in all. Of these, eleven are examples of impaction of a calculus at the lower end of the ureter: one was at a point three inches from the upper end; in one the obstruction was situated just where the ureter enters the broad ligament, and I successfully removed it by a prolongation of a lumbar incision after exploration of the kidney. In two cases the ureter is described as being filled with calculi and was removed. In the remaining case the exact position of impaction is not stated (Israel's).

Of the eleven cases in which calculi were impacted at the lower end of the ureter, in six the stones were situated close to the mouth of the duct and were removed in five by supra-pubic cystotomy, and in one case through the bladder after dilating the female urethra. (Three of these were reported by David Newman,* and three by Stanmore Bishop.†) The seventh case occurred in my own practice, and is especially interesting from the fact that I removed it in February, 1900, by an incision parallel to the sacrum, and it is, as far as I am aware, the first time a stone has been removed by this method in any country. The patient was a female, aged twenty-eight, and the stone was situated about 2 inches or 2½ inches above the orifice of the left ureter, and could be easily felt by vaginal examination when the patient lay upon her back or her right side, but was too high to reach through the roof of the vagina. To extract it, an incision 5 inches long was made parallel with and to the left of the vertebral spines and about 2 inches from the middle line extending from the level of the third sacral spine to a point about 1½ inches beyond the tip of the coccyx. The edge of the gluteus maximus and of the great sacro-sciatic ligament were divided, a bougie was passed into the rectum and another into the vagina to act as guides, and both these organs were pushed over to the right. A sound was passed into the bladder and a finger into the vagina, and after some trouble the left ureter was found, and the part containing the impacted stone was pushed up into the wound. The ureter was incised, the stone removed, and the incision closed with three Lembert's sutures. The stone was about the size of a hazel-nut, and its ends were faceted. The patient made a very good recovery, though a urinary fistula continued for nearly four weeks. She left the hospital quite well after a stay of seven weeks, and has had no return since of renal or ureteral pain or trouble on that side.

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* *Brit. Med. Journ.*, April 21st, 1900.

† *Edin. Med. Journ.*, July, 1899.

In the eighth case the right kidney and upper part of the ureter had been removed for calculous pyo-nephrosis and ureteritis together with a mass of calculi weighing six and a quarter ounces. Twenty days after the first operation I removed the lower end of the ureter quite down to the bladder through an incision by the side of the sacrum and coccyx similar to that just described. The ureter contained nine calculi, four of them each larger than dice; the mucous membrane of the duct was converted into a condition resembling skin (*see* Mr. Targett's report, *post*, p. 487). The patient quite recovered from the operations and both wounds healed completely, but she died somewhat suddenly four months later from anuria and uræmia, caused, I suspect, by calculous disease of the other kidney.

In two cases the calculi were removed by the vaginal route, and in one by the pre-rectal method.

Whether the stone is extracted through the loin, groin, sacral, vaginal, pre-rectal, or vesical route will depend on the part of the ureter in which it is lodged. It is safer to remove it by an extra-peritoneal rather than a trans-peritoneal operation, even when its existence and location have been determined by an intra-peritoneal search. If it is uncertain in which ureter the stone is, it is better to examine each through a lumbar incision than by laparotomy. If during an exploratory laparotomy a calculus should be found impacted in the pelvic section of the ureter, it should be displaced if possible either upwards above the brim of the pelvis or downwards into the bladder, but it may have to be left for a time in the ureter. Nothing should induce the surgeon ever to incise a ureter through the peritoneum unless he is absolutely sure of the aseptic state of the urine. He should close the abdomen and then and there remove the calculus by the retro-peritoneal method; or postpone the removal till the patient has recovered from the laparotomy. There should be no hesitation on this point, for with a calculus blocking the ureter it is impossible to be sure that the urine is aseptic. Indeed, the great probability, to say the least, is that it is not so. Granting that the wound in the ureter has been carefully sutured after a trans-peritoneal ureterotomy (a task by no means easy of accomplishment in the depths of the pelvis), and that the peritoneum has been replaced over the ureter and stitched in position, there can be no absolute security, with septic urine in contact with the wound, that union will follow, and extravasation and septic peritonitis not be the consequence.

In all cases the calculus should, if possible, be displaced by gentle pressure upwards and removed through an opening in the ureter a little away from the point at which it has been lodged. Here the coats are more likely to be less severely damaged, and the ureterotomy wound can be more easily sutured, and will be more likely to repair well than a wound at the seat of impaction would be. This practice is of great importance when the stone is below the brim of the bony pelvis, as by displacing the stone upwards it can very readily be removed through the lumbo-iliac incision, and the vaginal or the more serious and complicated sacral operation is thus avoided.

When the ureter is blocked near its upper end the calculus, if of a smooth surface and readily moved, should be pushed upwards into the renal pelvis and thence extracted. But this cannot always be safely done, and if the stone is of oxalate of lime and very rough on its surface, its inequalities stick into the wall and may cause tearing of the mucous lining of the ureter if any attempt is made to displace the stone upwards. I have had experience of the tenacity with which a small rough stone will attach itself to the ureteral walls. Other surgeons have failed in their endeavours to dislodge a stone, and others again have only succeeded with difficulty and with the hand in the peritoneal cavity (Hall and Lane). In one of Israel's cases the ureter was torn from the renal pelvis during the attempt. In Torrey's case the ureter was torn during an attempt to dilate it.

In a good many cases when the kidney is explored a calculus is found at the junction of the ureter and infundibulum, but very movable, falling into the ureteral orifice and back again into the renal pelvis like a ball valve; such a calculus should be pushed up into the renal pelvis before being removed, as the incision in the renal pelvis can readily be, and should be closed by sutures. There is no reason to cut the renal parenchyma for the extraction of a stone so placed, although this has been done in several recorded cases; it may however be requisite in order to make a thorough exploration of the kidney,

The incision in the ureter will be of a length proportionate to the size of the calculus and should be free enough to allow of the extraction without contusing the edge of the wound in the ureter. The calculus may be assisted out by forceps or a blunt probe or curette. A ureteral catheter should then be passed through the wound along the duct to the bladder below and the kidney above, so as to make sure of its permeability. If a second calculus is detected, an effort should be made to work it gently towards the wound in the ureter; if this is not possible, a second incision into the ureter at the place of the second obstruction should be made at the time of the operation, if the patient is in a condition to bear a prolongation of the anæsthetic and the shock attending an extension—perhaps a considerable extension—of the original wound, or perhaps the adoption of another route to the ureter. Otherwise the second stone must be removed at another time; in that case, if the original operation had been undertaken on account of calculous anuria, as the second calculus will be situated lower down, a fistulous opening would have to be maintained until the remaining obstruction had been successfully removed. When a stone is impacted in the ureter near the lower end, but too far off to be removed through the bladder (*see* Fig. 123, p. 140, Vol. II.) or the vagina, the sacral route should be employed. I have operated successfully in two cases by this route. In the male the pre-rectal route is available; thus Mr. Hurry Fenwick* successfully removed a calculus the size of a small apricot stone from the right ureter, 2 or 3 inches from the bladder, by dissecting between the rectum and bladder through a small transverse perineal incision.

Extraction of a stone impacted in the vesical part of its course or in a ureteral pouch should be effected *per urethram* in the female, if possible, and by perineal or supra-pubic cystotomy in the male. This method of extracting a calculus from the ureteral orifice, or the intermural part of the ureter, by dilating the urethra in the female and by a perineal incision in the male, was advocated by me in 1884, before my first book on the "Surgery of the Kidney" was published.† The perineal incision is said to have been practised by Desault and Garengeot. Unless the patient is very thin and the pelvis shallow the supra-pubic operation is to be preferred to the perineal. Tuffier has removed a ureteral calculus in this manner.

If the calculus is projecting at the ureteral orifice into the bladder, it should be drawn out with a lithotrite or forceps, or pressed out by the finger in the bladder, assisted by the finger of the other hand in the vagina or rectum pressing the stone forwards; if this cannot be done the mouth of the ureter and the mucous membrane covering the calculus may have to be incised. If the incision is limited to the tissue covering the calculus on the surface towards the interior of the bladder, there should be no fear of injuring the peritoneum or cellular tissue behind the bladder. A small scoop or curette may assist the process of disengaging the stone from the ureter. Whilst using the scoop as well as making the incision, the left forefinger in the vagina or rectum should prevent the calculus from slipping away from the ureteral orifice and so being pushed further up the duct, a thing not unlikely to happen, as the ureter will probably be dilated behind the stone.

If stenosis or a stricture of the ureter is present as well, it ought to be treated at once, after removing the calculus, by the method already described (*see* p. 435 *et seq.*); otherwise nephrectasis or a fistula will persist after the operation.

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* *Med. Soc. Trans.*, vol. xx., p. 240.

† See *American Journal of Medical Sciences*, October, 1884, p. 458.

CHAPTER XI.

FOREIGN BODIES IN THE URETER.

Other foreign substances besides calculi are met with in the ureter and become impacted for a time or permanently, or cause death by perforation or ulceration and extravasation. (1) Some are formed within the pelvis of the kidney or in the ureter itself; and (2) others have been introduced from outside the body.

Etiology.—Instances of the *first* class are blood-clots, concretions of pus or muco-pus, hydatids, sabulous material deposited from the urine as it passes from the kidney, or formed in the bladder and thence extending upwards through the ureteral orifice, and thick glairy matter secreted by the ureteral mucous membrane or descending from the renal infundibulum. In one recorded case of death from anuria, in a woman aged seventy, both ureters were filled with and obstructed by a glutinous, pasty material which contained no calculus or gravel (Chopart).

Instances of the *second* class are extremely rare. Galland (Charles Paul) based his thesis on "Foreign Bodies in the Ureter" upon a very remarkable case which he had the opportunity of observing in the service of M. Trélat. The stem of a tobacco-pipe made of horn, 8 cm. long and 11 mm. in circumference (*see* Galland, p. 50), was passed by a man aged forty-two into his own urethra; thence it passed completely into the bladder, and subsequently 2 cm. of it worked its way through the ureteral orifice on the right side and its extremity perforated the wall of the ureter.

Extravasation of the urine from the right kidney was followed by œdema, purplish redness of the skin, great pain, fever with some unconsciousness, and death on the fourteenth day after the introduction of the foreign body into the urethra. At the post-mortem examination the urethra and bladder were found healthy; the right kidney very congested; and the right ureter much dilated, ulcerated through at a point 2 cm. above its vesical orifice, and surrounded on its posterior aspect by very extensive peri-ureteritis. The pipe-stem had not ulcerated through the bladder wall into the ureter, but had fairly entered at the ureteral orifice.

Behind the ureter and between it and the abdominal wall was a cavity containing fibrino-purulent fluid. Extravasation of urine and suppuration extended along the whole length of the posterior aspect of the ureter, but not in front of the tube, to the diaphragm and right pleura; it had separated the peritoneum from the right iliac fossa and the right half of the anterior abdominal parietes as high as the umbilicus; and had extended into the cave of Retzius. The sub-peritoneal extravasation had caused general peritonitis. The abdominal muscles on the right side, especially the rectus and the ilio-psoas, were blackened, pulped, and disorganised.

The mode of entrance of the end of the pipe-stem into the ureter is explained by its somewhat curved outline, its flexibility, and the incessant muscular contractions of the bladder. The patient had passed urine nearly every hour.

Galland was unable to find any case similar to this one of Trélat, but he quotes two others in which foreign bodies were supposed to have gained entrance to the ureter by penetrating the intestine. The first of these was recorded by Bayle in 1686 —this is the case quoted by Baron Boyer from the *Journal des Savans*, March, 1686. It was that of a gendarme who was taken suddenly ill with acute pain below the umbilicus, fever, and an inflammatory swelling in the hypogastrium. An abscess was opened by an incision five fingers' breadths below the navel, from which urine and very stinking pus continued to escape for many months till death finally ensued. At the post-mortem examination the ureter towards its bladder end was ulcerated and full of pus, and a pin encrusted with salts was fixed in it.

In the other case, recorded by Peirce, a spiral shell was found in the ureter.

Chopart speaks of two occasions on which when sounding the bladder the end of the sound entered, as was supposed, the ureteral orifice.

Chopart, who quotes Bayle's case, was disposed to accept the explanation that the pin entered the ureter from the bowel; but Denucé and Galland do not accept it, and think it much more probable that foreign bodies reach the ureter through the bladder than through the alimentary canal.

There are three other cases on record of foreign bodies introduced from without. It is almost certain, from the conditions of the foreign bodies when passed with the urine, and the symptoms of the patients before they were passed, that in the two cases of gun-shot wound of the kidney quoted on pp. 159 and 160 of my "Surgical Diseases of the Kidney" (1885), the pieces of soldiers' uniform discharged *per urethram* had travelled the whole length of the ureter. These pieces of cloth, having been carried in with the shot, no doubt entered the ureter from the renal pelvis, and after sojourning in the body for some time (in Hennen's case seven months), escaped into the bladder and thence were voided with the urine.

The case related by Stromeyer, and quoted in the same work, is also a case of the same kind.

Cases of impaction of blood-clot in the ureter are cited by Rayer, Chopart, and Bloch. Blood-clots not unfrequently enter the ureter after accidental injury, operations, and hæmaturia from other causes situated in the kidney. As a rule, they pass along the duct to the bladder, sometimes causing little or no pain or trouble, sometimes giving rise to severe colic simulating the passage of a renal calculus, and attended with more or less blood in the urine. Cases by Bloch and Danyau * are very striking instances of blood-clot obstructing the ureter—the one recovered, the other died. Bonet reports the case of a man who died on the ninth day after a fall on his buttocks: the right ureter was obstructed by blood-clot, derived from a ruptured vessel in the kidney.

A small clot remaining in a calyx or in the renal pelvis has been known to form the nucleus of a calculus. A small clot impacted in the ureter may obstruct the passage of fluid blood subsequently escaping from the kidney; and this coagulating may lead to obliteration and fibrous condensation of the ureter, and to subsequent atrophy of the kidney. These were the conditions in a case of hæmato-nephrosis in a man under my care who died of cancer.

The changes which take place in a ureter containing blood-clot are the same as those which occur in a thrombosed vein. The clot may become partially or entirely absorbed, or decomposed, or organised into a fibrous cord.

Butler in the *Lancet* (1890, vol. i.) gives the case of a man aged forty-three who died of suppression of urine seventeen days after receiving a blow on the left side of the abdomen. Anuria commenced on the fourth day after the accident, and lasted for thirteen days up to the time of death. At the necropsy the right kidney was found cystic and atrophied, weighing only two drachms (120 grains), and measuring one inch and a half. The right ureter was pervious but thread-like. The left kidney was enlarged and bound down by recent and old adhesions. *The left ureter was greatly distended with urine, and a hard plug of blood-clot was impacted about its middle.* On section the renal pelvis was full of blood-clot, and there was a rent through one of the calyces into the renal substance, from which the blood had entered the renal pelvis. All the radicles of the renal vein were full of hard gritty thrombi.

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* Morris: "Surgical Diseases of the Kidney," pp. 139, 140, 303 (1885).

G. Barling * recorded the following case. A man aged fifty-four received a blow on his left loin; six months later a tumour as big as an orange developed, which slowly increased in size. No hæmaturia or any urinary symptom occurred throughout. Aspiration was tried, and subsequently lumbar nephrotomy was performed, and nearly five pints of chocolate fluid of urinous odour were removed. The cyst wall was sutured to the parietes, and the cavity drained. The patient recovered after prolonged suppuration with a urinary fistula. The ureter was plugged with blood-clot.

H. H. Mudd † records the case of a male child aged five who was run over, the wheel of a waggon passing over the right side. There was much shock for thirty-six hours, and hæmaturia continued for three days, and then quite disappeared, the urine afterwards being quite normal. A lumbar tumour appeared three weeks after the accident. This was aspirated, and twelve ounces of urine were withdrawn. Fever developed, and a few days later the tumour was incised and drained. Irregular fever continued, and pus and urine freely drained from the wound, showing the ureter was obstructed. As the patient was losing strength, lumbar nephrectomy was performed and complete recovery followed. The cause of the occlusion of the ureter was presumably blood-clot.

The symptoms.—These are not characteristic. If the foreign body is simply impacted in the ureter, the symptoms are those of stone in the kidney or in the ureter. If the foreign body is passing along the ureter, it may cause symptoms of colic like a stone in the renal pelvis or in its transit down the ureter. If the ureter is perforated by a foreign body, or ulcerates through the whole thickness of its walls, and suppuration follows extravasation, urine will escape through an incision made into the abscess or through the fistulous tract which is afterwards established; but it may not be possible to say that the urine is coming from the ureter direct: it might be coming from the kidney or from the bladder.

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* *Birm. Med. Review*, 1891.

† *Amer. Journ. Med. Sci.*, vol. i., 1889.

Diagnosis.—With blood-clot in the ureter there will probably be a history of injury or an operation. There may be a suddenly formed tumour in the renal region due to hæmato-nephrosis. There will be a history probably of hæmaturia before the obstruction occurs, some blood discoloration of the urine during the early stage of the impaction, and afterwards clear urine from the opposite kidney only, as long as the impaction lasts. Subsequently, when the clot shrinks or passes into the bladder, the urine will again become blood-stained, probably of a dirty thin chocolate or coffee colour from old retained blood, and if careful observation is kept an elongated dirty brown or dirty yellowish clot may one day be found in the urine. It must be remembered, however, that these same symptoms of hæmaturia may be caused by a renal calculus.

Infiltration of urine is not of itself an aid to diagnosis. It merely informs us that there is an actual communication between the urinary system and the adjacent cellular tissue, but gives no clue as to the site of this opening.

The symptoms caused by pus and muco-pus blocking the ureter are vague and indefinite to a degree so far as enabling the surgeon to diagnose the nature of the obstruction. In the event of hydatids being impacted in the ureter—a very rare cause and one which rarely gives rise to more than temporary obstruction —there will possibly be a history of hydatids having been previously passed in the urine, or a hydatid tumour may be discovered in the kidney or in some other part or organ of the individual.

Prognosis.—Blood-clots, hydatids, and plugs of pus and muco-pus generally pass sooner or later into the bladder, and thus the risk from them as causes of permanent obstruction of the ureter is very slight. After operations on the kidney it is not very uncommon to get pain along the course of the ureter, and perhaps sudden cessation of blood-coloured urine, owing to the presence of a blood-clot for a time in the ureter; but these symptoms as a rule soon cease, and urine more or less blood-coloured or containing a quantity of albumen is again voided for a short time, showing the re-establishment of the patency of the ureter.

The reasons why these foreign bodies are so usually expelled are their yielding, plastic nature, the weight of urine accumulating above them, and the contractions of the muscular coats of the ureter. In the case of blood-clots there is a further reason why they escape, namely, the contraction or shrinking of the clot itself. Still permanent occlusion from blood-clot, followed by the conversion of the whole ureter into a mere fibrous cord, does sometimes happen.

Treatment.—The medicinal treatment in these cases is the same as in impacted ureteral calculus; it can give ease to pain, and by regulating rather than absolutely checking muscular contraction of the wall of the ureter may facilitate the onward passage of the foreign substance. Morphia subcutaneously injected, chloroform inhalations, and hot stupes or baths are the remedies in common use. If hæmorrhage into the kidney is going on or threatens to recur, hot baths are contra-indicated, and styptics should be tried internally. If the bleeding persists, a lumbar incision will allow of catheterising the ureter from the renal pelvis; and nephrotomy, by relieving intra-capsular tension and giving a more direct exit for the blood, will be very likely to succeed in stopping the flow of blood into the ureter. In certain cases the operation should be tried. This failing, nephrectomy will be required.

G. Simon of Heidelberg suggested catheterisation of the ureter from the bladder; and in the case of blood-clot, muco-pus, or hydatid cyst it might be of some use by breaking up the foreign body. It may be tried if the diagnosis be fairly clear. In the case of impacted calculus catheterisation from the bladder is useless. If extravasation of urine occurs, free incision should be made into the retro-peritoneal tissues, and the ureter should be exposed if possible at the seat of perforation. If a foreign body has caused penetration, it should, of course, be removed if the surgeon is lucky enough to come down upon it or is led to it by catheterisation from above. If ulceration is the cause of the extravasation, the wound will possibly heal if the obstruction is removed. Drainage of the peri-ureteral tissues would be essential. Nephrectomy might be demanded by persistent fistula, or by stenosis, of the ureter, as well as by continuing hæmorrhage from a torn kidney.

In Hennen's and Stromeyer's cases one cannot but believe that a lumbar exploration of the kidney and ureter would have shortened the illness by enabling the foreign bodies to be removed.

CHAPTER XII.

TUMOURS OF THE URETER.

PRIMARY tumours of the ureter are extremely rare, but they occur. Both cystic and solid, innocent and malignant growths are recorded.*

The cases on record of primary tumours limited to the ureter, whether simple or malignant, are too few to allow of any very precise account being given of their diagnosis or symptoms. For the description of new growths of the renal pelvis the reader is referred to Chapter XXII., Vol. II., p. 1.

CYSTS.

Cysts of the ureter have been described by Rayer, Lendemann, Eve,† myself,‡ and more recently by Jackson Clarke,§ Voelcker,|| and Kahlden. These cysts appear as small vesicles the size of hemp seed on the mucous membrane, as is shown in the accompanying illustration of a specimen in which coccidia were present in the cysts; in this case similar cysts occupied the renal pelvis as well as the ureter, and the kidney was granular and cystic (Fig. 176).

The cases recorded by Eve and Jackson Clarke are also examples of cysts of parasitic origin due to the presence of psorosperms. In Eve's case the principal symptoms were acute pain, frequent and painful micturition, and severe hæmaturia—and death occurred seventeen days after the onset of the illness. After death the inner surfaces of both ureters were found to be thickly studded with yellowish rounded cysts, the size of millet seeds

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* Since this chapter was written (August, 1899) Albarran has published an excellent article on "Primary New Growths of the Renal Pelvis and Ureter" (*Annales des Maladies des Organes génito-urinaires*, July, 1900, p. 701). He has collected forty-two cases, but the cases of new growths originating in and limited to the ureter are not considered separately from those originating in and limited to the renal pelvis. In many of the cases both renal pelvis and ureter were affected. Those arising in the renal pelvis were twice as numerous (twelve out of eighteen) as those starting in the ureter.

† *Trans. Path. Soc. Lond.*, 1889, vol. xl.

‡ "Surgical Diseases of the Kidney," 1885, Plate III., facing p. 320.

§ *Trans. Path. Soc.*, 1892, vol. xliii.

|| *Trans. Path. Soc.*, 1898, vol. xlix.

(*v.* Hunterian Museum, No. 3644, C and D). Some of the cysts appeared to have ruptured and had left minute rounded apertures in the mucous membrane. Microscopically the cysts were seen to contain colloid material in which lay many ovoid bodies corresponding in size and appearance to pseudo-navicellæ. Some of them were rounded at one end and pointed at the other. The mucous membrane of the bladder was healthy. The hæmorrhage which occurred in this case was probably a coincidence and not an effect of the cysts.

In Jackson Clarke's case the kidney (left) was moderately hydro-nephrotic and contained a group of small cysts at its upper end. There were numerous cysts of a greenish-brown colour averaging the size of a hemp seed in the dilated renal pelvis and upper half of the ureter; there were also numerous small cysts at the neck of the bladder and at the vesical orifice of the ureter.

The contents of the cysts of the ureter were brownish, and on microscopical examination showed large and small, oval and irregular cells which contained bright globules.

After being hardened many of the cysts resembled those of Eve's case, but others had a different appearance and instead of large oval nucleated cells, small non-nucleated granular corpuscles occupied the clear spaces.

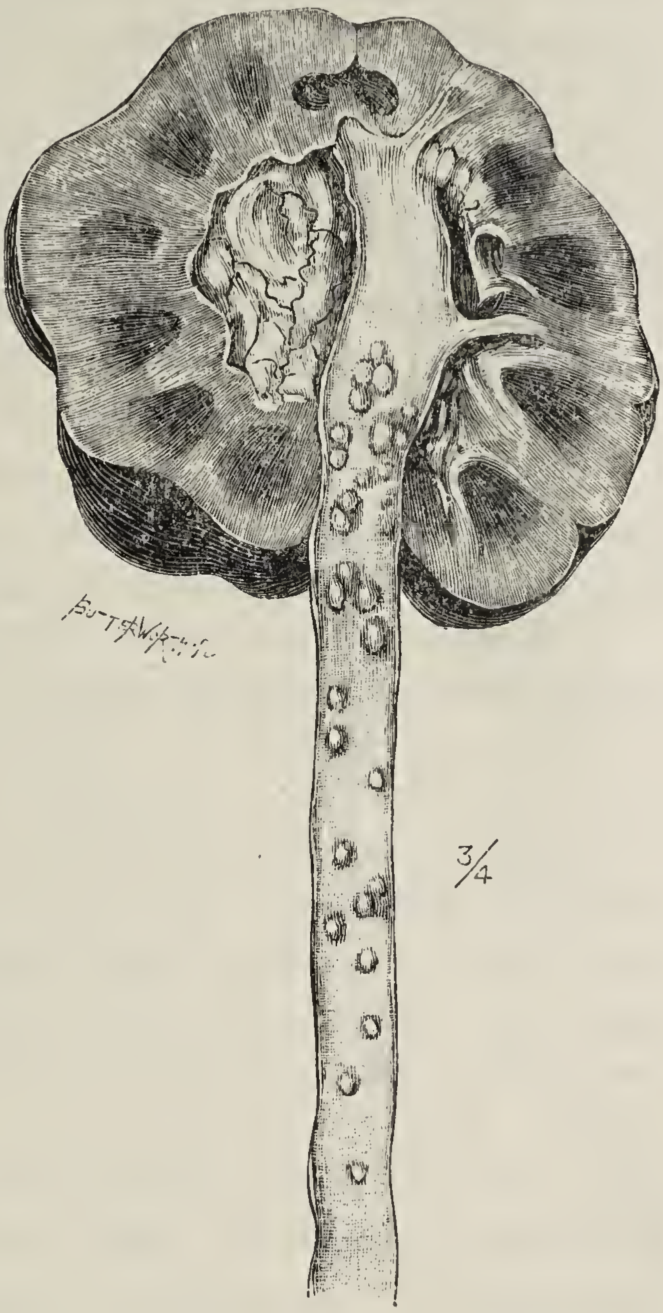

Fig. 176.—Cysts on the Mucous Membrane of the Ureter and Renal Pelvis, containing Coccidia; the Kidney is granular and cystic. (Middlesex Hospital Museum.)

It is probable that many cases of supposed mucous cysts of the ureter are in reality of parasitic origin. Targett* found this to be the case in a specimen which had been preserved in the museum of Guy's Hospital for fifty-three years, and coccidia were also found by Bland-Sutton in the specimen in the Middlesex Hospital Museum which had been preserved as an illustration of mucous cysts.

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* *Trans. Path. Soc. Lond.*, vol. xli., p. 170.

Some cysts no doubt are of glandular origin. Glands are not, however, always normally present, or uniformly distributed when present in the ureters of man. Wendt has described a few mucous glands scattered here and there in the mucous membrane, more especially of the upper part of the tube; and Bamberger states that in the human ureter glands are sometimes found which resemble small sebaceous follicles, entirely filled with cells.

In some few cases in man, mucous glands have become enlarged and formed mucous cysts in the ureters. Other cysts have been described as enlarged epithelial spaces of Brunn.

In Kahlden's case, which was probably of parasitic origin, ureteritis was present; and the cystic condition was bilateral and complicated with carcinoma of the bladder.

In Voelcker's case chronic interstitial nephritis was associated with cysts in the left renal pelvis and ureter.

PAPILLOMA.

Some half-dozen cases are on record of papillomata primarily affecting the ureter. In three the growths were exclusively in the ureter; in others the tumours extended into the renal pelvis, and in the case under Le Dentu and Albarran tufts of the growths also projected through the ureteral orifice into the bladder. This last-named case is of great interest as being the first in which the disease was diagnosed during life and deliberately treated for new growth by means of total nephro-ureterectomy.* The patient was a man aged thirty-three, who three years before he came under treatment suffered from rupture followed by traumatic stricture of the urethra. For four or five years he had had painful crises in the right lumbar region and groin. For two years these attacks recurred every two or three months, were attended with vomiting, and resembled renal colic; later on they recurred every five days and lasted forty-eight hours. They came on suddenly and without any assignable cause. No urine was passed during these periods, but afterwards abundant clear urine, occasionally mixed with a little red gravel, but no calculus or blood, was voided. A tumour, not tender, was present in the lumbar fossa. Nephrotomy on the right side was performed on November 15th, 1898. The kidney was small, hydro-nephrotic, and contained no stone. The patient recovered with a fistula, into which subsequently methylene blue was injected, and from this it was inferred that the ureter was obstructed, as the fluid did not reach the bladder. Cystoscopy subsequently showed the left ureteral orifice to be natural and papillomatous processes to be projecting at the right orifice. Two growths were found in the ureter, one at its junction with the infundibulum, the fringes of which were imprisoning an old clot and a small calculus; the other at the bladder orifice, where there was a fusiform dilatation receiving the index finger. At this latter part the ureter was filled by a papilloma with long fringes, also enclosing an old clot and a small uric acid calculus. The ureter between the growths was normal in aspect and volume.

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* *Bull. Acad. de Méd.*, Paris, 1899, 3rd series, vol. xli., pp. 240–243.

The extension to the upper end of the ureter occurs in a considerable proportion of cases of primary papilloma of the renal pelvis—in five out of twelve according to Albarran's list.

In eighteen out of forty-two cases collected by Albarran the tumour was of the papillary variety; of these eighteen, six were primarily of the ureter, and five extended into the ureter from the renal pelvis. But whether primarily of the ureter, or extending into it from the renal pelvis, the papillary growths may present themselves either (1) diffused throughout the whole length of the ureter, or (2) at the upper end of the duct only, or (3) the upper and lower ends may be affected, but not the intermediate part.

As in the bladder and renal pelvis, so also in the ureter, papillary tumours may be single or multiple—sessile or pedunculated—scattered villosities or single tufts or large arborescent masses.

Most of the papillary tumours are true simple papillomata, but some show signs, more or less marked and extensive, of malignancy. A superficial inspection may lead one to suppose that a growth is of simple non-malignant nature; and indeed *almost all* the growth may be of the true non-malignant papillomatous structure, and yet at some part—Albarran says especially at the attachment of the pedicle of the growth to the mucous membrane—the structure of epithelioma may be found in it.

Again, as in the bladder and renal pelvis, so in the ureter, simple papillomata may recur after removal; or one or more villous tufts may spring up in the ureter a year or less after the original disease in the kidney has been removed (Fenwick); or after years of existence as an innocent growth a papilloma may become epitheliomatous; or the recurrent tumour may be a true epithelioma as in Pantaloni's and one of Albarran's cases.

In Pantaloni's case the symptoms of hydro-nephrosis—presumably caused by a growth which after removal and very careful examination was found to be papilloma—had existed for twenty-seven years; yet the recurrence in the cicatrix was carcinomatous, and the disease became generalised.

A simple papilloma may co-exist with a carcinoma. Mr. Hurry Fenwick, as an illustration of how the cystoscope may mislead as to the proper treatment to adopt, mentions a case in which he discovered and removed a villous growth from the right ureteral orifice in the bladder, but a year later Mr. K. Thornton removed the right kidney, which was the seat of a carcinoma. The patient died of uræmia on the third day after the operation. Mr. Fenwick remarks, "Here an unimportant villous growth had been removed, leaving behind the real source of the disease—a renal cancer."

When the papillary tumours of the ureter or renal pelvis become epitheliomatous they take on the same course as tumours which from their outset are cancerous.

SARCOMA.

Malignant growths are found occasionally as primary tumours of the ureter. Cattani and Ribbert have observed *myxo-sarcomata* primarily affecting the tube. In Ribbert's case the growth invaded the ureter to within four inches of the bladder, and the renal pelvis also was involved. It occurred in a girl four years of age, who presented a tumour perceptible on palpation, and gave rise to the diagnosis of tumour of the kidney.

J. H. Targett* has recorded a case in a man aged forty-six of round-celled *sarcoma* of the right ureter, who died four months after the first symptoms. Severe pains in the loins and thigh, a large tumour in the umbilical and right lumbar regions, hæmaturia, and rapid emaciation, were the clinical features. There were secondary deposits in the liver. Within the bladder the growth projected at the ureteral orifice as a polypoid tumour the size of a cherry; the pedicle of this little tumour was covered with healthy mucous membrane, but its summit was superficially ulcerated. The whole length of the ureter was invaded by a new growth from without, which, having reached the interior of the duct, spread downwards to the bladder.

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* *Trans. Path. Soc. Lond.*, 1892.

CARCINOMA.

Rundle has published* a case of epithelioma of the ureter in a man aged forty-six, who for a year had had hydronephrosis attended by tumour, emaciation and weakness. The urine was clear without albumen, and though he had passed blood, he had not done so recently. There was no history of pain or renal colic. The hydronephrosis was tapped, but quickly refilled, and the patient rapidly lost strength, passed into a semi-comatose state, and soon died from exhaustion. The urinary organs were removed and examined by Mr. Targett, who found the hydronephrosis due to a large growth, involving the lowest three inches of the right ureter, with extensive secondary deposits of growth, in separate nodules or in clusters, in the mucous membrane, extending to within one inch of the renal pelvis. This ureter was three inches shorter than the left. A small polypoid tumour the size of a pea projected through the right ureteral orifice into the bladder; the vesical mucous membrane round about this orifice was roughened as if from superficial ulceration.

Numerous secondary deposits of growth were found in the liver, lungs, and abdominal lymphatic glands, which microscopical examination showed were squamous-celled epitheliomata without cell nests. The disease had commenced at the lower end of the ureter, just above the spot where it perforated the muscular coat of the bladder.

A case of primary carcinoma of the ureter has been recorded by Voelcker† in a man aged sixty-eight. The first symptom to be noticed was discoloration of urine, four months before the patient was admitted into hospital; on admission there was some resistance in the left iliac fossa on palpation, and the liver was enlarged, nodular, and tender. The patient rapidly lost flesh, and died within a few weeks. At the autopsy the kidney was small and distinctly hydronephrotic. A growth was found in the walls of the left ureter at its lowest two inches; it projected into the lumen of the tube in the form of delicate villous processes, which were covered with blood. On the outer side of the ureter was a mass of new growth, the size of a cherry, which was adherent to the pelvic brim. The bladder contained a blood-clot, free, in its cavity; and projecting from the vesical end of the left ureter was another small blood-clot. There was no new growth in the bladder. The right kidney and ureter were natural. The lymphatic glands along the left side of the aorta were enlarged, being infiltrated with new growth. The liver was much enlarged, the left lobe was almost entirely infiltrated with a pale, rather soft, new growth, and there were numerous secondary nodules in the right lobe. One small mass was present in the upper lobe of the right lung. No growths were found in the testicles, vesiculæ seminales, rectum, or alimentary canal. Microscopical examination of the tumour in the left ureter showed it to be a villous carcinoma. A delicate branching stroma of nucleated fibrous tissue was clad with numerous layers of large pyriform epithelial cells having large nuclei. The growth invaded the muscular layer and showed as a fibrous alveolated stroma containing epithelial cells. The secondary growth in the liver had a structure very similar to that in the ureter, the epithelial cells clothing the branching stroma being distinctly pyriform or kite-shaped.

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* *Trans. Path. Soc. Lond.*, vol. xlvii., p. 128 (1896).

† *Trans. Path. Soc. Lond.*, vol. xlvi., p. 133.

The points which led to the disease being considered a primary affection of the ureter were:—

1. The nature of the growth and its similarity to primary villous carcinoma of the bladder;

2. The want of any microscopical evidence of infiltration of the ureter from outside;

3. The similarity of the secondary growths in the liver to the primary growth;

4. The marked infiltration of the retro-peritoneal lymphatic glands on the left side only, and the marked infiltration of the left lobe of the liver.

The clinical history points to hæmaturia as the first sign of anything wrong.

Voelcker pointed out that a striking feature in this case was the large amount of secondary deposit in the liver, for it is rare to find the liver affected secondarily to primary malignant disease of the bladder. The reduced size of the left kidney suggested the possibility that a calculus might have caused some injury to the lower end of the ureter, which had been followed by the malignant growth, but of this there was no direct evidence.

Hecktœn has recorded a case of primary cancer of the right ureter, mistaken for an osteo-sarcoma of the ilium. It produced hydronephrosis and atrophy of the corresponding kidney.

Wissing and Blix have also recorded a case of epithelioma in which the growth originated in the ureter, and did not extend into or secondarily involve the renal pelvis.

Carcinomata appear to be somewhat less frequent than papillomata. In Albarran's list of new growths of the renal pelvis and ureter there were thirteen non-papillary epitheliomata to eighteen papillary tumours. In three of the thirteen cases the tumour started in the ureter and did not invade the renal pelvis; in three others both the ureter and the renal pelvis were involved. When the ureter is affected secondarily to the renal pelvis it is either by extension of the growth or by a veritable graft, which may be far away from the original growth. As with papilloma, so with carcinoma, the whole length of the ureter, or either or both of its extremities, without the intervening tract, may be involved.

Carcinoma may infiltrate the wall in the form of little nodules which more or less encroach upon the lumen of the ureter; or the ureter may become an indurated rigid cord. The type of carcinoma is more frequently alveolar, but it may be either cylindrical or squamous.

Albarran suggests that a certain number of squamous epitheliomata of the renal pelvis, ureter, and bladder are due to a preceding leucoplakia, a condition which, as Rokitansky and Hallé have shown, is brought about by the transformation of columnar and "transitional" into squamous epithelium.

The conversion, under prolonged irritation, of the lining wall of the ureter into a condition resembling skin, and the occasional presence of mucous glands in this part of the tube, were well shown in a case in which I removed by the sacral route the lower part of the ureter, which had for a long while been the resting place of several calculi. The specimen was carefully examined for me by Mr. Targett, who reported as follows:—

"This portion of ureter is much dilated, and measures one inch and a quarter at its widest part. The wall generally is somewhat thinned by distension, but the lining membrane is thick and silvery in appearance, like wrinkled epidermis. Under the microscope the wall is composed of unstriped muscle, arranged in layers and interlacing bundles. This is succeeded by a thick stratum of wavy cellular tissue, and the whole is lined by a modified mucous membrane, the characters of which closely resemble those of skin. It is distinctly divisible into cutis vera and epidermis. The former is made up of a basement row of short thick columnar epithelium, and two or three layers of oval and flattened cells, each with a nucleus. The epidermis is somewhat thicker than the cutis vera, and consists of laminated, denucleated squamous epithelium, thrown into folds by the elastic contraction of the deeper tissues. There are no true cutaneous appendages, and only one or two mucous glands."

Carcinoma of the ureter is highly malignant, as is well shown by the cases quoted above. The disease has a marked tendency to spread to the lymphatic glands, and to secondarily involve both near and distant organs.

The kidney and bladder, the peritoneum and the liver, the pleura and the lungs, are very prone to be affected.

Albarran found secondary growths in seven out of twelve cases of epithelioma of the renal pelvis and ureter collected by him.

Etiology.—There is little known as to the etiology of primary new growths of the ureter. They occur in middle and late life. They have been met with in both sexes, but in men more often than in women.

Urinary calculi in several of the cases have been present, embedded in or surrounded by the new growth, and it is not improbable that in some of these cases at least the irritation caused by the calculus may have been the exciting cause of the tumour.* In two cases of epithelioma the ureter was congenitally abnormal, but in only one of them does it seem possible that the abnormality was more than a coincidence. In this case there was a small diverticulum of the duct the size of a nut, close to the bladder; the epithelioma affected this diverticulum and the adjacent ureter proper in the form of nodules and ridges which encroached on the lumen of the ureter.

Symptoms.—As with new growths of the kidney, so with those which primarily attack the ureter, the three leading symptoms are hæmorrhage, tumour, and pain.

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* See *Path. Soc. Trans.*, 1888, and *Brit. Med. Journ.*, 1888, vol. i., p. 533.

Hæmaturia.—The first symptom is more frequently hæmorrhage than either tumour or pain. The characters of the hæmaturia are those of renal hæmaturia from renal new growths (*see* p. 576 *et seq.*, Vol. I.); and like the hæmaturia from growths in the bladder, it comes and goes without apparent reason, and is intermittent to a similar degree. Even when hæmaturia is not the first or an early symptom it is rarely absent throughout the whole course of a case. Tumour or pain, or both, may be simultaneous with hæmaturia at the outset, but less frequently than hæmaturia without either tumour or pain.

Tumour.—After hæmaturia a tumour is most frequently the earliest symptom. It is in comparison more frequent in new growths of the ureter than of the kidney, because the obstruction to the flow of urine along the ureter causes in time hydronephrosis. The characters of the tumour when due to obstruction are those which have been described under nephrectasis and intermittent nephrectasis (*see* Chapter XII., p. 395, Vol. I.).

Pain.—Although pain is in some cases absent throughout, it is occasionally an early or even the earliest indication that something is wrong. If the growth bleeds and a blood-clot passes along or is impacted in the ureter, renal colic with or without hæmaturia may be caused. The clot may be formed at the outset of the hæmorrhage and may so completely block the ureter as to prevent the blood from reaching the bladder; then if the hæmorrhage continues the blood may distend the renal pelvis and the ureter above the impacted clot, and thus hæmatonephrosis may be caused and a tumour due to nephrectasis from blood accumulation is the result.

In other instances the pain is slight and of a dull aching character. More frequently it is absent altogether, and sometimes there is no pain, even though long blood-clots, casts of the ureter, are passed into the bladder and extruded through the urethra.

Characters of the urine.—The urine will probably be quite healthy except for the presence of blood, but in some instances of tumours of the ureter, as also of tumours of the renal pelvis and bladder, careful and repeated microscopical examination reveals the presence of fragments of the growth or numerous epithelial cells which indicate the nature of the disease, though not the precise seat of the new growth.

A cystoscopic examination may disclose the projection from one of the ureteral orifices of a papillary process or a polypoid tumour; or blood may be seen issuing from the ureter into the bladder, or the ureteral orifice itself may be diseased (*see* Chapter III., Part II.). With the ureteral catheter a small quantity of urine containing blood and a number of cylindrical or pavement cells may possibly be drawn off which will indicate primary epithelioma either of the renal pelvis or of the ureter, though whether the growth is affecting the one or the other or both cannot be thus diagnosed.

Diagnosis.—There are the same difficulties in diagnosing new growths of the ureter as in diagnosing renal new growths, both in regard to the cause of the symptoms when tumour and pain are present, and in regard to the side on which the disease is situated when hæmaturia is the only symptom. Even when the side is indicated and a tumour is diagnosed it is still impossible to say whether the disease is primarily of and limited to the ureter, or primarily of and limited to the renal pelvis, or whether both these sections of the excretory duct are involved. It is even possible that the growth may be in the kidney or in the bladder and not in the excretory duct at all, but a large number of cylindrical and squamous epithelial elements in the urine would tend to exclude a tumour of the renal parenchyma; and a bimanual examination of the empty bladder under anæsthesia, or a cystoscopic examination, would reveal the presence of a tumour in the bladder.

It is not merely the presence in the urine of numerous epithelial cells of the cylindrical and squamous forms which indicates epithelial new growths of the renal pelvis and ureter—because abundant similar elements are cast off in the urine in cases of chronic pyelitis; but it is their presence in urine which is not puriform but which contains blood—the hæmaturia having the characters of the hæmaturia of new growths—which should lead to the diagnosis of tumour of the renal pelvis or ureter.

If with the cystoscope vascular fringes or a pedunculated tumour, or an ulcerated thickening at the orifice of the ureter, is detected, the symptom is pathognomonic and the diagnosis conclusive of disease of the ureter; but it affords no evidence as to whether the disease of the ureter is primary or secondary, innocent or malignant; even if typically innocent below, cancer may be situated higher up.

Prognosis.—The prognosis of all solid new growths of the ureter is unfavourable: (1) if papilloma, because they are apt to become malignant (epithelioma) if not removed, or to recur as papilloma or even to reappear as epithelioma if removed by ligature or erasion; (2) if carcinomatous or sarcomatous, because of their tendency to infiltrate and to become generalised in other tissues and organs; (3) because both the simple and the malignant epithelial new growths tend to spread by continuity along the ureter to the kidney and to the bladder, and by the process of grafting to the lower end of the ureter and the bladder; (4) because of the risk of the kidney becoming destroyed by dilatation and absorption (nephrectasis) owing to the obstruction caused by the ureteral new growth; (5) because of the increased risk of a hydronephrotic kidney becoming the seat of suppurative pyelo-nephritis either through the blood or in the event of any septic condition occurring in the lower urinary organs.

Pathological changes.—Reference has already been made to the propagation by continuity, and by diffusion or generalisation of the malignant new growths.

Then there are the secondary lesions of the kidney and of the perinephric and peri-ureteral tissues which result from ureteral obstruction and which may follow any ureteral new growth, whether a large mucous cyst or a papilloma, a carcinoma or a sarcoma.

The secondary lesions are nephrectasis and chronic perinephritis and peri-ureteritis, with or without suppuration. Nephrectasis may take the form of hydronephrosis, hæmato-nephrosis, or pyo-nephrosis. The first is much the most common.

Treatment.—If by palpation and the careful and repeated examination of the urine, aided by cystoscopic inspection and maybe by ureteral catheterisation, we are able to diagnose the presence of a primary tumour in the ureter, the treatment in most cases ought to be nephro-ureterectomy. If the disease is diffused in the ureteral walls, the only reliable course to pursue, either for the papillomata, the epitheliomata, or the new growths of connective tissue type (sarcomata, myxomata, etc.), is the removal of the whole ureter. It should be borne in mind by the surgeon who may be tempted to remove a papilloma by the forceps or by erasion that this kind of tumour is very apt to recur, as is frequently found, in the bladder; it is also apt to pass from a simple into a malignant form; and, moreover, there are transitional forms between a typical papilloma and a typical epithelioma, which make it very difficult at times to be sure whether a given case is of a simple or a malignant type. If a papilloma is pedunculated and solitary, the tumour may be twisted off with every reasonable prospect of a good and permanent result. There may be a well-limited sessile mass in some accessible part of the ureter, and vaginal, rectal, and bimanual examination under anæsthesia, and cystoscopic inspection of the bladder, as well as careful catheterisation of the ureter from above downwards at the time of the operation, may have fairly satisfied the surgeon that there is no other growth at the vesical orifice or in the intervening part of the ureter; in such a case it will be justifiable to excise the affected part of the duct and join the cut ends by one of the methods described in Chapter XVI. (p. 564 *et seq.*), and await future results.

If the vesical end of the ureter in a woman is affected, and the kidney and a great length of the ureter have been already removed through the lumbo-ilio-inguinal incision, the portion of the ureter between and below the folds of the broad ligament should be removed by the sacral route. In the male complete nephro-ureterectomy to the back of the bladder can be done at a single operation through the lumbo-iliac incision. If there is good reason to think the growth is limited to the vesical extremity of the ureter, the proximal end of the duct should be grafted into the bladder (*see* Vol. II., Chapter XVI., p. 564 *et seq.*) after excising the affected portion of the ureter. If the bladder around the ureteral orifice is involved, the treatment should be supra-pubic re-section of the diseased parts, followed by suture of the wound in the bladder, and grafting of the lower end of the ureter to the bladder opening—provided of course that the kidney and upper part of the ureter are healthy.

It is important to operate as early as possible, not only in malignant cases because of the tendency to infiltrate and generalise, but in all cases, benign as well as malignant, because of the risk of the kidney becoming disorganised by the obstruction in the ureter.

In all cases of tumours of doubtful nature, and of malignant new growths, the disease should be removed widely.

SECONDARY NEW GROWTHS OF THE URETER.

More common than primary are secondary new growths of the ureter. They result from extension by continuity, from the kidney or bladder or from the tissues outside the duct; or by impregnation of the ureteral walls by growths situated in the kidney or the renal pelvis.

In Hurry Fenwick's case of papilloma of the renal pelvis and calyces, the disease recurred in the ureter, necessitating the removal of the abdominal portion of the duct one year after nephrectomy had been performed for the primary growth.

In some of the cases reported as primary tumours of the ureter, it appears highly probable that the disease commenced outside the tube. The tumour in Targett's case of round-celled sarcoma of the ureter is described by him as invading the duct from without.

Campbell de Morgan many years ago, in relating a case of malignant tumour at the lower end of the spinal theca, secondary to a growth at the base of the cerebellum, pointed out that the situation of the secondary tumour was probably determined by the grafting of the cells of the primary tumour, which fell down the sheath of the spinal cord and attached themselves at its lower end. By a similar process the cells of a growth in the kidney or renal pelvis or upper end of the ureter, carried along by the urine, may become grafted upon the bladder or the ureteral wall anywhere along its course or at its lower extremity. Having once taken root on one side of the ureter, the new growth by contact inoculates the opposite side of the duct, just as we see disease spread by contact in the vulva and vagina, the under aspect of the tongue and floor of the mouth, on the prepuce and glans penis. From the bladder the ureter may be invaded by extension, by continuity upwards. Tumours of the bladder frequently originate about the orifices of the ureters and sometimes invade the ureter as they increase in growth. More frequently they obstruct or occlude the ureteral orifice, without spreading upwards into the duct, and cause nephrectasis, just as a tumour of the ureter itself or of the renal pelvis does. Vesical tumours thus extending into the ureter or occluding the ureteral orifice have, therefore, a clinical and diagnostic importance in relation to the kidney, as well as to the bladder; besides a pathological interest in relation to the ureter.

CHAPTER XIII.

URETERAL FISTULA.

The subject of ureteral fistula will always possess a peculiar interest to the practical surgeon, because it was for this condition that the kidney was first successfully removed by lumbar nephrectomy,[1] the operator, as will for ever be remembered, being Gustav Simon of Heidelberg.

Fistulous communications of the ureter are established with the cutaneous surface, with the vagina, uterus, or intestine.

Etiology.—Ureteral fistula may be either congenital or acquired; the acquired may be either traumatic or pathological.

1. In the *congenital fistula* the ureter opens abnormally, owing to an error of development, within the vagina, upon the vulva, in the wall of the urethra, beneath the prepuce, upon the abdominal wall, or into the rectum or some other part of the intestine (*see* chapter on Abnormalities of the Ureter, p. 288, Vol. II.).

2. The *traumatic fistulæ* are due to various forms of injury, including operation wounds. They are thus either accidental or intentional, *i.e.* surgical. A few cases have been caused by accidents other than those occurring during surgical operations. Some have been the direct effect of the vulnerating body (*see* chapter on Penetrating Wounds of the Ureter, p. 359, Vol. II.); others a consequence of ulceration, or of the evacuation by the surgeon of a urinous or purulent collection behind the peritoneum following an injury (*see* chapter on Sub-parietal Wounds of the Ureter, p. 330, Vol. II.). In some instances a ureteral fistula opening on the cutaneous surface is deliberately established by the surgeon. This was done by Bardenheuer in 1882, after removing an impacted ureteral calculus and finding that the urine did not subsequently reach the bladder; by Le Dentu and Pozzi; by R. Harrison in a case of ectopia vesicæ; and by myself in a case of enormous hydronephrosis in 1883, and in a case of congenital hydro-ureterosis in 1893.*

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* *Lancet*, June, 1895, and "Hunt. Lect.," Table VI., Nos. 1 and 7.

A very frequent cause of traumatic ureteral fistula is the sloughing of the soft tissues following prolonged and difficult labour. In some of these cases the sloughing has involved the neck of the uterus, in others the vagina, as well as the ureter, and a uretero-uterine or uretero-vaginal fistula has resulted.

Operation wounds inflicted either through the abdominal cavity or through the vagina are the most frequent cause of accidental ureteral fistulæ. In vaginal hysterectomy, a portion of the lower end of one or both ureters has been cut away, or the tube has sloughed after the application to it of a ligature or pressure forceps. When the operation is performed for cancer of the cervix uteri, and the tissues around are infiltrated, injury to the ureters is often unavoidable unless some of the affected tissues are left behind. Even when the disease is in quite an early stage and limited to the uterine structure, there is risk to the ureters unless the greatest precaution is used.

In abdominal hysterectomy, as also in the removal of ovarian and other abdominal tumours, the ureter has been often injured or completely divided. Sir Spencer Wells, in a communication to the Royal Medical Chirurgical Society,* in which he reported the first successful case of total extirpation of a gravid cancerous uterus, mentioned that in six out of ninety-four published cases of abdominal hysterectomy, one ureter had been divided, and that in two other cases both ureters had been cut across.

These accidents in surgery, far from being confined to a bygone day, have become much more frequent since the vulgarisation of vaginal hysterectomy and the greater frequency of the abdominal method of complete extirpation of the uterus. Quite recently I witnessed an operation for the vaginal extirpation of a cancerous uterus in which both ureters were unwittingly divided, and the surgical literature of the present time affords abundant evidence of the frequency of ureteral wounds inflicted in the course of surgical operation. Segond, Schwartz, Routier and Michaux, who count their vaginal hysterectomies by hundreds, deny the frequency of the operation as a cause of uretero-vaginal fistula. But however free in their skilled and practised hands the operation may be, Tuffier was able to refer in the discussion at the Surgical Society of Paris † to a list of forty collected cases of fistula, all following vaginal hysterectomy, and it is certain many occur which are not published. Indeed, it is largely on account of these injuries that so much attention has been given of late years to experimental researches and the minute operative details of ureteral anastomosis and ureteral grafting.

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* *Roy. Med.-Chir. Trans.*, 1881, vol. lxv., p. 34.

† *Bull. et Mém. de la Soc. de Chirur.*, t. xxi., 1895, p. 262 and p. 344.

3. *Pathological fistulæ* are caused by (1) abscess, lumbar, iliac or pelvic, in the immediate neighbourhood of the ureter; (2) ulceration secondary to calculus or tuberculous ureteritis; (3) the pressure of a tumour or the encroachment of a malignant growth, either of which may lead to ulceration or sloughing of the ureter; (4) lumbar fistula following nephrectomy and caused by the continuation of the ureteritis which existed at the time of the operation.

Morbid anatomy.—Often in pathological fistulæ the actual communication with the ureter involves only one side of the wall of the ureter, whereas a traumatic fistula, whether caused during a surgical operation or otherwise, more frequently engages its whole circumference. The deep orifice of the fistula intentionally established has in all recorded cases, except my own, been the upper end of the completely divided ureter; and the same is the condition in fistulæ following lumbar nephrectomy.

The *external orifice* is generally situated on the loin, groin, or some other part of the abdominal wall, or else in the vagina, uterus or bowel; rarely it communicates with the peritoneal cavity, and then the case usually terminates rapidly and fatally.

Dupuytren records a case of ureteral fistula opening into the peritoneum, and caused by calculous pyo-nephrosis. It occurred in a young lady who some time before her death had had an abscess situated in the left renal region opened by puncture. She died after prolonged sufferings from chronic peritonitis, numerous circumscribed intra- and extra-peritoneal abscesses (some of which were fæcal), and ulceration of the intestinal walls from without inwards at several points. The left kidney was reduced to the condition of a pouch with fibrous walls.

The fistulæ which form in connection with **the abdominal portion of the ureter** open as a rule on the cutaneous surface of the loin, or in the inguinal or at the umbilical region, or in the median line between the umbilicus and the pubes; or they may open into some portion of the intestines.

Thus the fistulæ which have followed an accidental rupture or wound of the ureter have been situated in the loin, and have been either the immediate result of a gun-shot or punctured wound, or else have been the sequel of a retro-peritoneal abscess which has burst or been opened by the surgeon. In one or two instances ulceration has led to a communication between such a retro-peritoneal swelling and some portion of the bowel. In a few cases there are two cutaneous openings, one in the loin and one elsewhere on the abdominal wall.

In some cases in which the ureter has been completely or nearly divided during the removal of an abdominal tumour, the aseptic urine has traversed the peritoneal cavity and escaped at the abdominal wound; the greater portion of the wound has healed, and only a small aperture for the escape of the urine has been left. But if the wound in the ureter is small, or for some other reason the urine escapes more slowly, peritoneal adhesions may form and shut off the extravasated urine from the general peritoneal cavity. If this pent-up urine comes into contact with any effused blood, or is invaded by pyogenic bacteria which have escaped from the intestinal tract, an abscess forms which, after bursting or being opened, leaves a fistulous tract discharging urine and pus.

The fistulæ which occur in connection with **the lower end of the ureter,** whether due to congenital malformation, to pathological causes, to prolonged labour, or to injuries inflicted by the surgeon, open nearly always into the neck of the uterus, into the vagina, or upon some portion of the external genito-urinary organs. A few open into the rectum.

The fistulæ which follow subcutaneous and penetrating wounds, and open in the lumbar or antero-lateral portion of the abdominal wall between the costal margins and the groin, in all respects resemble similarly situated fistulæ of renal origin (*see* Chapter XIV., p. 374, Vol. I.).

The track or course of the fistula may be short and direct or long and sinuous. When made by the surgeon intentionally, the cut end of the ureter is fixed to the skin so that cutaneous and mucous surfaces are continuous.

The walls of the fistula may be thick, tough, muscular, and fibrous, or lined with a soft, spongy, easily bleeding granulation tissue. If the external orifice of the fistula is kept clean and does not contract, little or no change may take place in the kidney, otherwise uretero-pyelo-nephritis or pyo-nephrosis arises. I have two patients living and in good health years after the establishment of a renal cutaneous fistula (nephrotresis), one of them having only one kidney. There is no reason why the same longevity should not follow ureteral fistula (ureterotresis).

When a fistulous opening is formed on the cutaneous surface of the body, it is often difficult to be sure of the exact situation of its connection with the ureter. The cause of the fistula, the situation of its external orifice, and the direction of its canal may sometimes, but not always, assist us in arriving at a pretty accurate idea.

Prognosis.—The tendency of fistulæ is to remain unhealed; they are noxious and distressing to bear, but not necessarily dangerous to life. The risk is from pyelo-nephritis or renal obstruction.

Symptoms and diagnosis.—A ureteral fistula gives exit to urine, or to urine and pus, or it may be to pus only. The kind of discharge depends upon whether the abnormal opening in the ureter (1) is in direct communication with the kidney as well as with the external orifice, in which case it will be urine; this urine may of course contain blood or pus if the kidney is not healthy; or (2) is in communication with an abscess cavity or a pus-secreting sinus or track situated between it and the external opening, as well as with the kidney, in which case there will be pus as well as urine; or (3) is without any communication with the kidney, owing either to occlusion of the proximal part of the ureter or to the kidney having been removed, and to the fistula being kept open by a diseased ureter. If there is not a communication with the kidney, pus only will escape, unless it be that urine flows or is propelled back from the bladder along the ureter—a rare but possible occurrence which has been noticed by Hartmann and Desnos. The urine may escape more or less continuously or *guttatim*. If the external orifice becomes stenosed, or superficially healed over or filled up by granulations, the urine and pus are retained, an abscess is likely to form and fever and rigors will probably occur. Ureteritis and uretero-pyelo-nephritis are very probable, but not necessary complications. It is often quite impossible to diagnose between a fistula communicating with the renal pelvis and one opening into the ureter. The means of diagnosing between ureteral and vesical fistula are described further on.

Treatment of cutaneous fistulæ.—The abdominal fistulæ which follow operations need not long detain us. If almost immediately after an abdominal section urine should be found escaping from the incision, the treatment should be the same as if the injury to the ureter had been discovered before the completion of the operation. The wound should be opened up and the ends of the divided ureter united together, or the upper end should be anastomosed with the bladder, or attached to the cutaneous surface of a fresh opening in the abdominal wall either of the loin or antero-lateral aspect of the abdomen; or the two ends should be brought to the surface of the cœliotomy wound and fixed there for subsequent treatment; or nephrectomy should be performed. The choice of these alternatives must be made on the same grounds as if the injury had been recognised and dealt with before the closure of the abdomen (*see* Chapter on Injuries of the Ureter, p. 366, Vol. II.).

When secondary abscesses have formed, the flow of urine into the suppurating space must be made to cease either by detaching the proximal part of the ureter and fixing its cut end to the skin in the lumbar or antero-lateral area of the abdomen, when it is possible to find the tube and dissect it from its dense connections in the abscess wall; or by performing nephrectomy. It will in all probability be quite impossible to detach both ends of the ureter so as to join them together. The dense inflammatory and cicatricial tissues with which they have been surrounded will almost certainly prevent this. Moreover, from the connection of the ureter with the abscess cavity, ascending uretero-pyelo-nephritis may have been set up; and if this has greatly destroyed the kidney, nephrectomy will be the best if not the only available procedure which can lead to cure, and it ought to be performed provided the opposite kidney is known to be healthy. The proper treatment of lumbar fistula following nephrectomy and due to ureteritis, if the fistula is persistent, and especially if it is due to tuberculous ureteritis, is ureterectomy.

URETERO-VAGINAL AND URETERO-UTERINE FISTULA OF ACQUIRED ORIGIN.

With very few exceptions the cases of uretero-vaginal and uretero-uterine fistulæ which the surgeon will be called upon to treat will be those of traumatic or pathological origin. The congenital fistulæ due to the opening of the ureter into the vagina or upon some part of the external genito-urinary organs are very rare, though they are by far the most frequent of the congenital forms.

We will now consider first the uretero-uterine and uretero-vaginal fistula, the result of injury or of pelvic abscess, tuberculous ureteritis, or some other pathological conditions, and their proper treatment; and afterwards deal with the congenital deformities.

The uretero-uterine fistulæ concern (1) that portion of the ureter which is in relation with the neck of the uterus in the lowest part of the broad ligament, and onwards from this to its junction with the bladder; and (2) that in relation with the cervix uteri between the os internum and the os externum. As the fistulous opening is always on the cervix uteri, the uretero-uterine fistulæ are often spoken of as *uretero-cervical.*

Berard was the first to make known the uretero-uterine fistulæ. They are probably not common, as Hegar and Kaltenbach refer only to nine published cases, and Nebe and Iversen, conjointly, only to fourteen such cases (*see* p. 512).

The uretero-vaginal fistulæ concern (1) the ureter anywhere between its entrance into the broad ligament and its termination in the bladder; and (2) the dome of the vagina or the upper third of the anterior and antero-lateral wall behind the base of the "vaginal trigone of Pawlik." This trigone is a fairly smooth surface on the front wall of the vagina corresponding to the trigone of the bladder. It is limited by three projecting folds of mucous membrane, of which the one that forms the base is transverse, and is situated in front of the neck of the uterus and on a slightly higher level than the inter-ureteral ridge in the bladder. Like this ridge in the bladder, it is somewhat convex in front, with its extremities corresponding to the vesical orifices of the ureters. The lateral boundaries of this trigone are formed of folds of mucous membrane which commence a little behind the point corresponding to the vesical orifice of the urethra, and diverge as they proceed backwards to the extremities of the transverse fold just described.

The uretero-vaginal fistulæ which follow prolonged labour affect that portion of the ureter between the neck of the uterus and the vesical orifice of the ureter. Those which follow ureteritis, pelvic suppuration, or abdominal or vaginal hysterectomy may involve the ureter much farther from its termination than the cervix uteri.

Etiology.—There are several distinct sets of *traumatic* causes:

1. *Vaginal extirpation of the uterus* is probably by far the commonest cause at the present time. Many such cases have been cured by operative treatment, and it is probably this fact

which has led to their publication. But many others have occurred in which either treatment by operation has been tried and failed, or no operative treatment whatever has been adopted, and for these or other reasons no record of them has appeared.

Abdominal hysterectomy, for uterine myomata and cancer of the uterus, is answerable, probably, for as many more.

2. *Difficult and prolonged parturition,* which was formerly the most frequent cause of these fistulæ, is now second only to the surgical accidents above alluded to.

The vesical orifice of the ureter is situated about 3 cm. below the os uteri externum, and compression of the part of the bladder through which the ureter passes, between the fœtal head and the pubes, will produce either a uretero-uterine or a uretero-vaginal fistula, according as the slough which results is on a level with the uterine neck or lower down on the vaginal wall. Fistulæ caused in this way are, however, much more frequently vesico-vaginal than uretero-vaginal; and uretero-vaginal are much more frequent than uretero-uterine.

3. *The prolonged use of a uterine pessary* is said to have caused uretero-vaginal fistula. Weil mentions a case in which it was caused by wearing a Meyer's pessary introduced and left unheeded in position. Landau has also seen a fistula of this kind produced by wearing a pessary. I have had under care a woman with a large vesico-vaginal fistula from this cause. She was admitted into my cancer ward at the Middlesex Hospital under the impression that she was suffering from epithelioma of the vagina.

4. Torsion of the distal end of the ureter in the course of ovariotomy or vaginal or abdominal hysterectomy, or the removal of an adherent pyosalpinx, may produce it; it may also be caused by the pressure of a pelvic tumour.

In the course of abdominal or vaginal hysterectomy, the ureter may be divided, completely or incompletely transversely or obliquely, or only notched either by the scalpel or scissors. If caused in this manner, the leakage of urine will most likely commence during the operation, and may be noticed by the operator immediately after the damage has been done.

Or the vitality of the ureter may be destroyed in the course of the operation by being nipped by clamp or pressure forceps, or included in a ligature, or by being torsioned as Zweifel suggests. When this is the case, no leakage of urine will occur until after the separation of the slough. M. Routier reports a case which occurred in his practice as arising from an unusual gangrenous process in the wound, resulting in a fistula of the ureter into the vagina at the end of twenty-eight days. Any ulceration or suppuration of the wound may in the same way lead to the formation of a fistula some weeks even after the operation.

R. Condamin reports a case of uretero-vaginal fistula which resulted from puncturing a swelling which was taken to be a left-sided pyosalpinx. Some left-side abdominal pain had existed for six months, and a swelling developed on the left side of the pelvis, which was felt through the vaginal wall. It yielded pus on being punctured, but afterwards urine escaped by the vagina. Nephrectomy was performed. The kidney was enlarged from pyelo-nephritis.*

Tuberculous ureteritis occasionally leads to uretero-vaginal fistula. I had under my charge in 1894 a girl, aged thirteen, who had had incontinence of urine for seven months due to this cause. It concerned the left ureter, and the left kidney also was tuberculous.†

Poirier‡ states that he has injected 200 ureters and dissected 400; and that in the course of these researches he met with ureters strictured and deformed by inflammatory exudations near their junction with the bladder; that above the strictured points the ureters were dilated and attained the diameter of nearly 1 cm. This dilatation of the ureter above a stricture explains perhaps how the side of the ureter may be damaged and thus give rise to a temporary fistula which heals spontaneously. In cases of double ureter, of which Poirier observed seven, the two tubes intimately joined together follow the normal course of the ureter, so that this abnormality does not increase the danger of their being damaged in vaginal hysterectomy.

In the application of a clamp, the ureter may be caught lengthwise, and the slough may then affect the highest point which has been compressed; if this be so, the fistulous orifice of the ureter may open into a retro-peritoneal space, extending any distance between the brim of the true pelvis and the vaginal cicatrix, and instead of opening immediately into the vagina, may do so through a cellular tissue track. Boldt§ gives a case in which the injury of the ureter was caused by a clamp applied to the ureter lengthwise very high up. The

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* *Lyon Méd.*, 1893, 74, p. 341.

† Table vii., No. 15, "Hunterian Lectures."

‡ *Bull. et Mém. Soc. de Chir.*, t. 21, p. 286.

§ *Amer. Journ. of Obstetrics*, 1896, p. 848.

clamp remained for two days, and was followed by necrosis of the upper part of the compressed portion of the ureter, and closure by adhesive inflammation of the bladder end. About the sixth day urine found its way behind the peritoneum from the upper segment of the ureter into the vagina. Tuffier in his paper states that eight out of ten cases caused by cutting instruments are right-sided fistula, whereas those caused by forcipressure forceps, etc., are about equal for the two ureters. Tuffier's actual figures show that twenty out of twenty-seven in which the side was stated were right ureters.*

The pathological causes are pelvic suppuration; ulceration following ascending suppurative, or tuberculous, or calculous ureteritis; ulceration leading to perforation of the ureter at the site of an impacted calculus; and the destruction of the lower end of the ureter caused by carcinoma of the vagina or uterus.

The pathological cases, and those of traumatic origin attended by a loss of substance of the ureter, are very likely to be followed by stenosis of the fistulous orifice, and later on by destructive disease of the kidney.

Diagnosis and symptoms.—If a ureter is injured by clamp or ligature, dribbling of urine does not occur until the necrosed tissue separates, which will probably not be for some four or five days, or more.

Until the fistula is established the diagnosis must be difficult, but meanwhile the diminution in the quantity of urine excreted, the presence of anuria or partial anuria together with pain in the kidney of the injured ureter, tenderness on pressure over the kidney and ureter, associated probably with vomiting, are symptoms which should lead the operator to suspect what has happened, and what shortly to expect. Cystoscopic examination will probably clear up any doubts; and if the ureteral catheter is introduced into a still pervious vesical end of the divided ureter, no urine will come through the catheter; but if introduced into the uninjured ureter, urine will escape by the catheter. This test is, however, open to fallacy.

Again, a careful examination of the vaginal vault—with proper specula and a good light, when the patient is in the elevated dorsal, or better still the knee-pectoral position—will probably enable the operator to detect the fistulous opening, though it be only the size of a pin's head, or less.

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* *Bull. et Mém. Soc. de la Chirur.*, t. 21 p. 345.

When a ureteral catheter is introduced into this opening the diagnosis will be cleared up if urine is seen escaping from it.

Some objection has been raised against catheterising the fistulous opening on the ground that it is likely to set up ureteritis, but with proper aseptic precautions there is no special reason to fear this result. There are, however, fallacies attending the use of the catheter. Boldt has illustrated, by a case of his own, that it is possible for the catheter or sound to enter a false passage, and give the impression that it is in the ureter when it is not.

It must not be forgotten, too, that it may be impossible to bring the ureteral orifice into view, and that the bladder may be so contracted, and incapable even of moderate distension, that no satisfactory examination can be made of the vesical orifices of the ureters. Such I was informed was the case in a patient with uretero-vaginal fistula, who suffered the terrible calamity of having the wrong kidney removed.

A further source of error in the case referred to was the temporary ligation of the ureter near the kidney. This woman, after the damage done to her ureter during abdominal hysterectomy, passed on an average from the bladder twenty-four ounces of urine in the twenty-four hours, besides having a continual discharge of urine into the vagina. After the application of the temporary test ligature for half an hour to the ureter supposed to be at fault—the vagina having been previously dried and the bladder emptied—it was found that the vagina was still dry, and that half an ounce of urine was removed from the bladder. This seemed to show that the kidney which discharged its urine naturally into the bladder was free, and was secreting during the experiment at the same rate as it had been observed to do for several days previously. I do not know the real explanation of the fallacy in this case, but I can imagine it to be that both ends of the divided ureter opened into a small cavity or cellular tissue space, and this in turn opened into the vagina; and that a dry plug placed in the vagina during the experiment acted in some way by crowding up the vaginal wall to conduct the urine from the false passage into the still patent lower portion of the ureter, and so into the bladder. The case shows that reliance cannot be placed upon the result of a temporary ligature at a distance from the fistulous opening, unless the bladder and vagina are left quite free during the course of the experiment;

certainly no plugs should be crowded into the upper end of the vagina.

On occasions when less urine is passed from the fistula more pain will probably be felt in the renal region and along the course of the ureter affected; then a copious discharge of urine may occur with a corresponding relief of pain. This is likely to be the condition when the uretero-vaginal fistula is indirect, *i.e.* when a retro-peritoneal abscess cavity connects the ureter with the vagina. In such a case the accumulation of pus in the abscess cavity may completely obstruct the kidney. If anything prevents the flow of urine, such as pressure from an abscess, or stricture of the orifice of the fistula, pain and septic absorption attended with fever and rigors will be caused, and be followed after a time by pyo-nephrosis. This is more especially prone to be the result if ureteritis is already existing.

Freund * relates a case of uretero-uterine fistula in which the retention of a laminary tent in the neck of the uterus caused pain in the kidneys, vomiting, and fever, by compressing the ureteral orifice and thereby obstructing the flow of urine and provoking ureteral and renal distension.

If complete anuria follows an operation, we have grounds for suspecting that both ureters have been clamped or tied, especially if the patient complains of pain and tenderness in the renal regions and is distressed by nausea and vomiting. With such symptoms existing Boldt recommends that a cystoscopic examination of the bladder should be made without delay, and if with the aid of the ureteral catheters the lower ends of the ureters are found occluded, the ligatures or clamps should at once be released, so that the patency of the ureters may be re-established, as in cases under Zweifel and Gusserow, recorded by Hochstetter, and a case under Mr. Purcell at the London Cancer Hospital.

Though complete anuria or the discharge of only a small quantity of urine from the bladder is a very suspicious symptom after hysterectomy or any such operation, still it must be remembered that by itself it is no proof of the ureters or of a ureter being involved. Complete or partial anuria, as well as persistent nausea and vomiting, not very unfrequently follow serious operations where there is no question of any damage to the ureters or kidneys. Such symptoms are sometimes the effects of an anæsthetic and of the loss of blood, or are due to the shock of the operation.

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* Freund, *Klin. Beiträge zur Gyn.*, 1882, p. 84.

When a fistula is established it is very desirable to make a comparative examination of the urine passed through the bladder and that passed into the vagina. If that coming from the kidney which discharges by the fistula is largely mixed with pus, or if it be excessive in quantity and of very low specific gravity, doubt or more than doubt will be caused as to the integrity of the kidney, and it will be a question as to whether nephrectomy should not be performed instead of any plastic operation.

If there is pus in the urine, the probability is that the kidney is the seat of suppurative pyelo-nephritis, and it will be right under these circumstances to remove the kidney; H. J. Boldt was for this reason impelled to do nephrectomy in one of his cases, and the operation saved his patient's life. But in some instances the structural deterioration indicated by polyuria may be prevented from getting worse if the fistula is successfully obliterated.

The diagnosis between uretero-cervical and uretero-vaginal fistula on the one hand and vesico-uterine and vesico-vaginal fistula on the other is ordinarily a simple matter.

As it is only the urine from one kidney which escapes by the fistula, that which is secreted by the opposite organ accumulates normally in the bladder, and this fact serves to distinguish the ureteral from the vesical forms. If after the bladder has been emptied by a catheter the patient is made to sit upon a commode for an hour or two, so that the urine which trickles from the vagina is all collected in the receptacle, and if at the end of this time the bladder is again emptied by the catheter into a separate vessel, and the two lots of urine are about the same in quantity, there is the strongest proof of the fistula being ureteral and involving one ureter only. Of course, when both ureters are involved, as they sometimes are, this simple but important means of diagnosis is wanting; for, whether the fistula involves the bladder or both ureters at once, the whole of the urine will in the sitting posture equally escape from the vagina.

The attitude of the patient does not affect the escape of urine from a ureteral fistula. In ureteral cases, no matter whether the woman is lying on her back, or side, or abdomen, whether she is sitting or standing, the urine escapes from the vagina just the same. This is not invariably the case in vesico-uterine and vesico-vaginal fistulæ.

The situation of a fistula near the junction of the side with the base of the "vaginal trigone" should excite suspicions of its ureteral origin, and these suspicions will be strengthened if digital examination *per vaginam* discloses a thickening in the course of the ureter of the corresponding side. This thickening is often the result of ureteritis and peri-ureteritis set up by the fistulous condition, when not itself the cause of the fistula. Repeated failures in operative treatment are more likely to occur with ureteral than with vesical fistulæ.

The orifice of a true uretero-vaginal fistula is often very small, and may be situated upon a minute mass of granulations, or hidden from view in a recess or behind a band of cicatricial tissue. The orifice of a vesico-vaginal or of a uretero-vesico-vaginal fistula may be very large.

The patent orifice of the ureter may be found upon one of the free borders of a vesico-vaginal fistula situated at the side of the trigone; or it may be seen on the surface of the bladder just beyond the free edge of the fistulous aperture. In some uretero-vesico-vaginal fistulæ it is possible to make sure of the diagnosis by passing a fine bougie along the ureter and another into the bladder from the fistulous opening.

True uretero-vaginal or uretero-cervical fistulæ are rare, except as the result of surgical operations, of ulceration following ureteritis, and some forms of pelvic suppuration. When due to sloughing after prolonged parturition, the bladder is commonly involved as well as the ureter, and both communicate with the vagina or cervix uteri.

Pozzi thinks that what usually takes place is that after the fall of the slough the ureter becomes fused with the vagina or the partially destroyed neck of the uterus, and owing to the incessant dribbling of urine from it a fistulous opening in connection with it persists, whilst the portion of the wound connected with the bladder cicatrises and contracts; and thus a small ureteral orifice remains from which urine incessantly escapes, but which is very difficult to find amongst the irregularities of the cicatricial area.

Verneuil has shown that this variety of fistula—the uretero-vesico-vaginal and uretero-vesico-uterine—has a great tendency to cause stricture, followed by hydro-ureterosis and hydro-nephrosis, as the result of the partial healing of surfaces which involve at once the bladder and the end of the ureter.

The injection of milk or coloured water into the bladder will cause no escape of the fluid at the abnormal opening if it be a simple uretero-cervical or uretero-vaginal fistula; but if the bladder be involved, alone or in conjunction with the ureter, the milk or coloured water will escape from the cervix uteri or directly into the vagina, as the case may be.

This test however cannot be absolutely relied upon in doubtful cases, for when the uretero-vaginal fistula concerns quite the lower end of the ureter, the fluid injected into the bladder may escape into the vagina through the vesical segment of the ureter. Duplay records a case in which this happened. The milk test is however valuable in conjunction with other evidence.

As a summary it may be stated that if urine flows steadily from the vagina when the bladder is empty, if the urine escaping from the vagina differs materially from that passed by the bladder, if the amount of the urine flowing from the vagina during a given time equals or exceeds that accumulated in the bladder during the same time, and if a probe passed into the vaginal fistula cannot be touched by a sound passed *per urethram* into the bladder, we have evidence enough to prove the fistula to be of ureteral as distinct from vesical nature.

From urethro-vaginal fistulæ those connected with the ureter are easily diagnosed by the continual drop-by-drop escape of urine from the ureter, whereas in urethro-vaginal fistulæ the urine is only discharged into the vagina during the act of micturition.

Prognosis.—The general health may keep good, or it may become greatly deteriorated by the annoyance and irritation caused by the constant contact of urine with the vaginal mucous membrane, or by the ascending inflammation and suppuration along the ureter to the kidney or along the uterus to the Fallopian tubes and to the ovaries.

When the fistula opens into the neck of the uterus, chronic inflammation, sclerosis, and ulceration may so change the cervix uteri as to give it the appearance and somewhat the feeling of carcinoma.

These fistulæ have no tendency to spontaneous cure, except when they involve only a small portion of the ureteral walls, *i.e.* when the division of the ureter is incomplete. This kind of injury is more likely to occur if the ureter prior to the operation of vaginal hysterectomy has become dilated, so that one side only of the wall becomes caught in the point of the compression forceps or cut by the knife or scissors. Most cases of vaginal fistulæ which heal spontaneously are in all probability small vesico-vaginal, not uretero-vaginal fistulæ. In the first days after the separation of sloughs a good deal of repair may take place; and the original opening may diminish still further by the contraction of the cicatricial tissue; but a minute orifice, often difficult to find, persists, and as a rule proves most difficult to cure. The uretero-uterine fistulæ are even more unfavourable both as to prognosis and treatment than the uretero-vaginal. In all alike there are the dangers of distension of the ureter and kidney, due to the contraction of the tissues around the lower end of the affected ureter, and of ascending uretero-pyelo-nephritis and of metro-salpingitis.

Morbid anatomy.—When due to injury inflicted in the course of vaginal or abdominal hysterectomy, these fistulæ open in the cicatrix at the top of the vagina. The cicatrix is generally much puckered and very irregular, and it is difficult and sometimes impossible to discover the exact position of the fistulous aperture.

In the majority of cases the orifice of the fistula is the ureter itself, which has become incorporated with the cicatricial tissues; but in some instances, when there has been a loss of an inch or two of the tube, the opening is not directly into the vagina, but into a retro-peritoneal connective tissue space, from which a fistulous communication leads into the vagina.

The bladder end of the ureter may be either pervious or impervious; and if pervious, and especially if dilated, urine may flow backwards through it during the half-empty condition of the bladder. The vesical end of the tube is specially likely to be impervious if the ureter has been compressed for a day or two by a clamp, or if it is embedded in dense inflammatory material. Intestinal, omental, and other adhesions within the pelvis, and extending even into the abdomen proper, may mask the ureter and prevent the possibility of isolating it even by dissection.

T. A. Emmet was of opinion that uretero-vaginal fistula is never the immediate effect of childbirth, but is always due to pelvic suppuration. He says: "The ureter can scarcely communicate directly with the vagina as a result of childbirth," because the ureters have no direct connection with the sides of the vagina, but only an indirect one through the connective tissue of the pelvis; "but when the loss of tissue has been extensive the ureter sometimes becomes rolled out on to the vaginal wall in the process of healing." When the ureter leaks into the *cul-de-sac* behind the cervix uteri the lesion is, in Emmet's opinion, always connected with an attack of cellulitis, and this cellulitis must terminate in an abscess in order to bring about a uretero-vaginal fistula. The abscess drags the ureter upwards to the point where it becomes attached by adhesive inflammation to the vagina. Thus the ureter becomes bent at an angle, and the passage of urine into the bladder being partially obstructed leads to inflammation and ulceration, and ultimately to a fistula. Whenever uretero-vaginal fistula follows childbirth Emmet was convinced that the explanation he offers as to its relation to cellulitis will be found correct. He refers to a case in which a pelvic abscess made its way through into the *cul-de-sac* of the vagina, and afterwards apparently all the urine of one kidney escaped by this route. He had seen two cases in which the ureter was divided in the same neighbourhood by the surgeon when opening a pelvic abscess through the vagina. The ureter having been dragged up to a level with the roof of the vagina, and it being impossible to determine its presence there, injury to it may be unavoidable in some cases if a bistoury be used for opening the abscess; there would be less risk in employing a trocar and cannula. If adhesions have formed between the ureter and the side of the vagina, such an accident as Emmet refers to cannot be guarded against.

Though Emmet's explanation is probably correct for many of the cases following childbirth, there is no reason to doubt that in other instances the fistulæ are the direct result of mortification, following direct pressure upon the sides of the middle third of the vagina, in juxtaposition with which the ureters course on their way to enter the substance of the vesical wall.

Treatment.—A correct knowledge of the anatomical relations of the ureters, and the recollection that they are likely to be considerably varied by the growth of uterine and other pelvic and abdominal tumours, are the best safeguards against the surgical accidents which result in these fistulæ. Even with every proper precaution, such accidents will sometimes occur; and occasionally the surgeon will find it desirable to deliberately establish such a fistula. This may have to be done when the ureter is embedded in infiltrated tissues or passes in the wall or through the cavity of an abscess.

If the ureter, instead of being cut, has been compressed by ligature or clamp, it may be possible to prevent a fistula by removing the compressing force as soon as the renal and general symptoms of an obstructed ureter show themselves.

With a view to future favourable conditions for the cure of a fistula, it is well every time the ureter is injured in the course of vaginal hysterectomy for the surgeon at once to make a track for the injured tube beneath the mucous membrane of the vagina, and fasten its cut end upon the surface of the vagina, under the base of the bladder, so that by a subsequent plastic vaginal operation the ureteral fistula can be turned directly into the bladder. In the event of wounding a ureter in the course of abdominal hysterectomy, the proper treatment would be to immediately anastomose the ends or perform vesical grafting, according to the circumstances of the particular case. As there is always a risk that the kidney may be damaged by the constriction which is liable to occur about the fistulous orifice, uretero-vaginal and uretero-uterine fistulæ should be operated upon as soon as the diagnosis is made. *There should be no procrastination in the hope of a spontaneous cure.*

Spontaneous recoveries and cures after simple cauterisation of the fistulous orifice have indeed occurred, but they are very rare, and are only likely to happen in incomplete division of the ureter, *i.e.* when there has been a minute loss of substance on one side only of the tube. Zweifel and Gusserow have however known of spontaneous healing of ureteral fistulæ the results of childbirth.

Hahn relates a case of uretero-uterine fistula in which the patient became pregnant, and after a normal delivery the urine no longer escaped into the cervix uteri, though it is not known whether the cure was permanent or not.

Tuffier has reported a case of spontaneous cure after nine months' existence of a uretero-vaginal fistula following hysterectomy, and alludes to a similar one under one of his colleagues. Lavisé and Gallet* have had similar experience in two other cases.

In many cases of uretero-vaginal and uretero-uterine fistula no surgical treatment has been attempted; in other cases, however, nephrectomy has been performed either after the failure of other methods of operating or without any attempt at less radical surgical treatment.

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* *Ann. de la Soc. de Chir. de Bruxelles*, 1894.

The first suggestion of nephrectomy in these cases originated with Simon in 1869. Zweifel, in 1878, and Credé, in 1881, were the first who practised it. Simon's original case, operated upon in 1869, was one of a traumatic fistula opening just above the pubes.

It is quite certain that nephrectomy has been too readily regarded as the proper remedy for these infirmities, and that many healthy kidneys have been sacrificed without any attempt having been made to cure the fistula by other and more conservative measures.

Vaginal hysterectomy having of late, as I have said, greatly increased the number of uretero-vaginal fistulæ, they have become the subject of much attention, and the progress of ureteral surgery within the last year or two has been the means of opening up many new methods for their treatment. The result has been that nephrectomy is rightly falling out of use except in otherwise intractable and hopeless cases.

It has been especially in uretero-uterine fistula following childbirth that plastic operations have been unsuccessful, and that nephrectomy has been performed after other surgical procedures have been tried and failed.

Of the cases of uretero-vaginal fistula collected by Nebe, Iversen, Pozzi, and others, nearly one-half of those which have undergone operative treatment have been straightway submitted to nephrectomy; and of the rest nearly as many were treated by kolpo-kleisis as by all the plastic operations put together.

In nearly one-half of the whole number of cases, both uretero-uterine (fourteen cases) and uretero-vaginal (thirty-nine cases), no operative treatment whatever seems to have been tried. But it should be remembered that until comparatively recently the obliteration of these fistulæ was considered to be beyond the resources of surgical art, and that it is only since the great increase in the number of traumatic fistulæ, caused by and following surgical operations, that so much attention has been given to the development of the surgery of the ureter with a view to their repair.

The various operations which have been practised for the cure of these fistulæ may be grouped as follows:—

A. *Plastic operations.*

1. Direct implantation of the fistulous orifice into the bladder.
2. Grafting the ureter to the bladder through the vagina.
3. Grafting the ureter into the bladder by the extra-peritoneal

route, including the supra-pubic trans-vesical method of Bazy and Baumm.

4. Grafting the ureter to the bladder by the abdominal route.

B. The permanent obliteration of the genital passage below the situation of the fistula, and establishing a free vesico-vaginal communication.

(*a*) Hystero-kleisis, and (*b*) kolpo-kleisis.

That a considerable number of plastic operations have been devised for the cure of these fistulæ is a fact which of itself shows the intractable character of the defect to be remedied; still, some of them have been followed by very gratifying success. They all have in view the object of re-establishing the urine track through the bladder, either by invaginating the fistulous aperture into the bladder, after first incising the vesico-vaginal septum, or by grafting the ureter directly into the bladder. The plastic operations are, it must be admitted, often extremely difficult and tedious; and, though not dangerous to life, they often require a repetition of attempts before success is obtained, and occasionally cause inflammation of the ureter and kidney, more especially if stenosis of the ureteral orifice follows the operation.

Hystero-kleisis and kolpo-kleisis are also operations of a plastic nature, but their object is to stop the incontinence of urine by converting part of the genital passages into a urine receptacle in direct communication with the bladder itself.

Choice of operation for uretero-vaginal fistulæ.—The perfect success of reported cases of abdominal cysto-ureterotresis for these forms of fistulæ, as well as for divided ureters, when performed as a primary operation at the time of the accident, should not lead to its general adoption for every case of uretero-vaginal fistula.

The safest and most direct method of operating should always be adopted. Therefore, in spite of their difficulty in technique and uncertainty in results, one of the older plastic operations through the vagina, preferably Duhrssen's, should always be first tried where there is any chance whatever of its succeeding. Failing this, the vaginal cysto-ureterotresis is the next method of choice; and only when these are thought to be impossible or have failed should one of the grafting operations through the abdomen be performed. Of these latter, Witzel's, when its performance is feasible, is the operation which best meets the requirements, immediate and remote, of these cases; next, either Novarro's or Bazy's.

Bazy is a strong advocate for the abdominal "uretero-cysto-neostomy" in preference to any of the vaginal operations. He argues that all the abdominal operations which have been performed have ended in cures—the two of Novarro, his own two cases, and those of Rouffart of Brussels, of Pozzi, and of Tuffier. He would add to these M. Chaput's successful case of colo-ureterotresis. It is true that in Novarro's operations urine is said to have escaped by the wound for a fortnight; and that the same thing happened in Rouffart's case, where, to make matters worse, the urine was purulent and therefore septic. But even in these most unfavourable cases the recovery was ultimately complete, showing, as he (Bazy) thinks, that the operation is benign and efficacious, whilst it is certainly not difficult of performance.

With Chaput the order of preference is (1) vaginal cysto-ureterotresis, (2) abdominal cysto-ureterotresis, (3) colo-ureterotresis.

In the opinions of Segond and Tuffier the vaginal should have preference. The strictly intra-peritoneal operations and the trans-abdominal "extra-peritoneal" operation of Veit have the disadvantages of allowing intestinal or omental adhesions to form around the portion of ureter exposed in and stretching across the peritoneal cavity, causing possible traction on the graft before healing is complete, and leading possibly to stenosis of the ureter, or even to intestinal obstruction later on.

Kolpo-kleisis is an operation easy of performance, but is only strictly suitable for women past the child-bearing period; unless the condition of the opposite kidney or the general state of health of the patient puts nephrectomy out of the question. Even then it should not be adopted unless the patient is anxious to be cured of her fistula at the cost of her sexual competency. After kolpo-kleisis has been successfully performed, the husband has been known to demand the restoration of the vagina; and women themselves have withdrawn from the operation, preferring to continue with their urinary infirmity rather than make the sacrifice of their sexual capacity.

It is less objectionable after removal of the uterus and its appendages, and in elderly women, than when the uterus remains and the catamenia persist; because when the catamenial flux and uterine mucous secretions have to be discharged through the bladder with the urine it is only a matter of time before pyelo-nephritis or metro-salpingitis will occur. Even after the uterus and appendages have been removed, there is still a liability to the formation of phosphatic calculi and to the development of the gravest renal changes, owing to the decomposition of residual urine in the newly-formed vesico-vaginal receptacle.

Nephrectomy, like kolpo-kleisis, should be reserved for cases in which the plastic operations proper are inapplicable or unsuccessful. Nephrectomy should be preferred to kolpo-kleisis if marital relations are to be continued, and if the opposite kidney is known to be healthy.

In uretero-uterine fistulæ, which are rarely amenable to plastic operations of any kind, except hystero-kleisis and kolpo-kleisis, nephrectomy is the only resource if the genital functions are to be preserved.

In uretero-vaginal fistula it is only when the ureter has been wounded very high up; or after failure of every other expedient in the way of plastic operations, including vaginal and abdominal cysto-ureterotresis; or when the abdominal operations for any reason are unadvisable, that nephrectomy is proper. In such cases as Emmet's and Boldt's, where the ureter was divided high up and opened into an abscess track which communicated with the vagina, nephrectomy or intestinal or cutaneous grafting might be the only alternatives to kolpo-kleisis, as the ureter might be too short to reach the bladder by any method.

Finally, nephrectomy would be requisite if the kidney of the injured ureter were greatly diseased. A moderate degree only of nephritis or pyelo-nephritis, or hydro-nephrosis, would not warrant nephrectomy, for it is reasonable to hope that under proper diet and treatment these morbid stages of the kidney will be cured if the ureter is again put into proper physiological connection with the bladder.

Chaput's successful cases of grafting the ureter into the colon and sigmoid flexure had led him to the opinion that when neither vaginal nor abdominal implantation into the bladder is possible the intestinal grafting is to be preferred to nephrectomy.

Although since Simon in 1869 first suggested nephrectomy for the cure of a ureteral fistula, this operation has up to the present too frequently been performed for these cases, yet with our present knowledge of the surgery of the ureter, it may, I consider, be laid down as a maxim that *it is inexcusable to sacrifice a healthy kidney for the cure of a uretero-vaginal fistula, except as a last resource.*

CONGENITAL URETERAL FISTULÆ.

These are due to abnormal terminations of the lower end of the ureter. If the ureter, instead of opening into the bladder, ends in front of the sphincter vesicæ upon some part of the urethra, or into some part of the seminal passages, or the vagina, or upon the vulva, the individual suffers from incontinence of urine. Sometimes the ending of the ureter is in the rectum, and then incontinence of urine is not a symptom, although troublesome and frequent defæcation may be. In some cases in which the ureter has ended in the rectum there has been an imperforate anus. Many of these anomalies are associated with other congenital deformities; and, indeed, the rarer varieties, such as openings into the rectum, or upon the vulva, or in the lower parts of the vagina, are seldom found except in monsters or extremely mal-developed fœtuses. In other cases there may be a double uterus or a double vagina, and one of the vaginæ may communicate with the rectum, whilst the other receives the only ureter present (*see* chapter on Abnormalities of the Ureter, p. 288, Vol. II.).

When the vesical end of the ureter is impervious the upper end may not have any communication with the kidney, or the kidney may be atrophied or hydro-nephrotic. In most of these cases surgical treatment is either useless or impossible.

In cases in which the ureter ends in the urethra, in the uterus or in the vagina, and there are not other malformations to contra-indicate an attempt to cure the fistula, the operation of choice will be uretero-vesical grafting into a part of the bladder as near the normal ureteral orifice as possible: in the male by the trans-abdominal retro-peritoneal method, and in the female by the vaginal method. After dividing the ureter, a ligature should be placed round the stump end, which should be left *in situ*, and may confidently be expected to atrophy.

Baumm,* in a young female, performed uretero-vesical grafting, operating within the bladder after first resorting to supra-pubic cystotomy; the operation was done on account of a double ureter on the right side, the supernumerary one ending at the mouth of the urethra. Baumm chose this operation because the patient was a virgin, but he does not recommend it, and thinks it unnecessarily severe. He considers the operation of grafting through the vagina preferable (see *post*, p. 580).

* *Centralblatt für Gyn.*, November 17th, 1892, p. 336.

Davenport [*] performed the vaginal operation in a case in which the ureter traversed the vesico-vaginal septum and opened close to the external orifice of the urethra, thus causing incontinence.

Wölfler and Bois independently performed much the same operation for the cure of congenital ureteral fistula (A. Boari). This operation was performed by the urethra and consisted in making a uretero-vesical opening between a dilated pouch of the ureter and the bladder.

Wölfler's case [†] concerned a child aged twelve. The child passed all its urine by the urethra, but between the acts of micturition urine was constantly trickling away from a minute opening just below the meatus. On exploring this opening a small catheter passed into a cavity containing 80 to 100 grammes of urine. There was no communication between this cavity and the bladder. Wölfler diagnosed an abnormal orifice of one ureter with dilatation of the retro-vesical segment of the duct. He established a communication between this dilatation and the bladder, closed the inferior opening, and thus cured the patient of his fistula.

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[*] Quoted by Fenger, *Annals of Surgery*, 1894, vol. xx., p. 287.

[†] *Wiener Med. Wochens.*, No. 22.

CHAPTER XIV.

METHODS OF EXPOSING THE PELVIS OF THE KIDNEY AND THE URETER IN SURGICAL OPERATIONS.

In the course of every operation on the kidney, excepting for ordinary movable kidney without obstruction, the ureter ought to be tested with a flexible sound—to be passed into the ureter, if possible, through the cavity of the kidney when this has been opened along the convex border of the organ; and if not, then through a small incision made expressly in the back of the renal pelvis.

Occasionally the renal pelvis or the upper end of the ureter has to be exposed when no operation is contemplated upon the renal parenchyma—as, for instance, in searching for the exact seat of an obstruction in the ureter, to assist in the repair of a ureteral fistula, or to apply a temporary ligature with the view of ascertaining with which kidney a uretero-vaginal or uretero-uterine fistula communicates.

With the recent advances in the surgery of the ureter many occasions arise when it is necessary to expose the ureter in various parts of its course other than near the renal pelvis, with the view to ureterotomy, resection of the ureter, secondary ureterectomy (*i.e.* where the kidney has been previously taken away), or for operations for the cure of ureteral fistulæ. Thus it happens that the ureter may have to be examined under very different circumstances, viz. (1) when it is not known which of the two ureters is at fault; (2) when it is known which ureter, but not the exact part of it which is involved; and (3) when it is known which ureter and also the exact part of it which requires to be operated upon.

It follows that in many cases before the ureter is actually operated upon one or both of them must be examined; and therefore the first question to decide is, How can the ureter best be reached for the purpose of being examined? And the second question is, Ought the operation to be performed through the same route as the examination is made, or by another?

There are two chief ways of reaching any part of the ureter, namely, the trans-peritoneal and the extra-peritoneal, each of which has certain advantages. For reaching the pelvic part of the ureter there are several varieties of the extra-peritoneal method. Each of these will now be described in some detail.

The trans-peritoneal method.—When the surgeon is uncertain not only as to which part of a ureter but as to which ureter is affected, there is good reason for performing cœliotomy in the median line and examining across the peritoneal cavity. When it is a question not as to which ureter but as to what part of the ureter is involved, the trans-peritoneal method through an incision along the semi-lunar line of the affected side, or through a curvilinear incision partly along this line but curved inwards at its lower end towards the middle of Poupart's ligament, is to be preferred, as being more directly over the line of the ureter than the median operation. But, as in the case of the kidney and the renal pelvis, so still more in that of the ureter, the examination by the trans-peritoneal route can only be imperfect and incomplete. There are anatomical conditions which make it so. In the first place, the ureter by its small volume and want of resistance does not present as the kidney does a solid mass which can be seen and felt through the peritoneum covering it. There are parts of the abdominal section of the ureter which are completely hidden by the viscera. On the right side this is the case almost throughout its course; first the duodenum, then, but only when distended, the ascending colon and the cæcum are in front of it. On the left side the sigmoid flexure overlaps it in front. In the pelvic section the sigmoid flexure also falls in front of the left ureter and prevents the fingers coming into contact with the duct unless the gut is drawn well to the right. In the male, except for the sigmoid flexure on the left side, nothing lies in front of the pelvic part of the ureters; but in the female the ovaries, Fallopian tubes, and the broad ligaments intervene and cover them.

In addition to the above anatomical difficulties, there may be the obstacles, often considerable, of great intestinal distension and a superabundance of sub-peritoneal fat.

Mode of search.—In searching for the ureter, with the hand in the abdomen, we should in the first place seek for the kidney, feel for the hilum, and then, when the colon is drawn as much as possible over towards the opposite side, pass the finger-tips downwards on the front of the psoas muscle, along the usual course of the ureter as far as the point at which it crosses the bifurcation of the common iliac artery, or the first quarter of an inch of the external iliac artery. If the examination concerns only the pelvic section of the ureter, the search may commence at the point where it crosses the iliac vessels. From this point onwards to its termination in the bladder a knowledge of the normal direction of the ureter is our only guide. In the male pelvis this course is easily followed by the fingers of the surgeon, as nothing crosses or lies in front of the ureters on the left side except the sigmoid flexure, which can be easily pulled aside, and on each side the vas deferens, which gets to the inner side of the ureter near the bladder. In the female the portion of the ureter which lies in the broad ligament cannot be felt from the peritoneal cavity without separating the anterior from the posterior layer of the ligament, and passing the fingers deeply down to the pelvic floor, where the ureter lies below the uterine vessels.

The examination of the ureter will be rendered easier if the tube is distended, or if it is made hard and prominent at some point by the pressure of a calculus; or rigid by a stricture, stenosis, calcification of its walls, or by introducing into it a bougie either from the bladder or the renal pelvis. In one respect however the trans-peritoneal examination of the ureter is less uncertain than that of the kidney, for if a calculus is present it can be felt on any aspect of the tube, and does not need a puncture or an incision to reveal it, as is so often the case with small calculi in the kidney. Otherwise the difficulties in finding and tracing the ureter may be insuperable. Even when greatly enlarged the ureter has not always been recognised, but has been mistaken for the bowel; and in further illustration of the difficulties in detecting the ureter by the trans-peritoneal method it may be mentioned that a chain of lymphatic glands in the line of the ureter was for a moment thought by M. Poncet to be the ureter irregularly dilated; and M. Chaput,* in the course of an operation for grafting the ureter into the colon, first mistook the ureter for the iliac vein, and then opened a vein which he mistook for the ureter.

It may be needful, in order to examine or even to find the ureter, to divide the peritoneum at the back of the abdomen. In doing so the serous membrane should be cut at some little distance on the outer side of the line of the ureter, and should then be detached towards the median line. By this means blood-vessels are avoided, and a flap of the serous membrane is made, which can be afterwards readjusted and sutured in place.

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* *Arch. Gén. de Méd.*, Janvier, 1894, pp. 12, 13.

When the peritoneum is thus raised the ureter must be sought for, not upon the surface of the tissues exposed, but upon the posterior or detached face of the serous membrane. It should be remembered that the ureter is closely adherent to the peritoneum, and separates with it when that membrane is raised, as M. Gigon specially pointed out in 1856.*

In spite of these anatomical and clinical drawbacks, the trans-peritoneal method may afford some information when nothing is known as to the side or situation of the ureteral obstruction. But when by means of it the cause and seat of the obstruction has been found, we must proceed to ureterotomy or resection by an extra-peritoneal route.

The extra-peritoneal method.—The ureter in its whole length can be explored without opening the peritoneum. For this purpose an incision should be made through the abdominal parietes down to the peritoneum, which should be raised and drawn towards the median line with the subjacent intestines, and the ureter sought for and traced on the detached surface of the serous membrane.

The position of the patient.—At first, during the exploration of the lumbar portion of the ureter, the patient should be lying on the opposite side with his abdomen turned somewhat towards the table; afterwards, during the exploration of the pelvic portion of the tube, he should be rolled over so as still to be somewhat on his opposite side, but with his back inclined to the table. A cushion is not required under the flank in any part of this operation; it tends to prevent the viscera falling forwards during the first part, and is needless in the second part.

The line of incision.—The incision commences in the lumbar region, a little below the twelfth rib, at the outer edge of the sacro-lumbar mass of muscles. It then takes a very obliquely transverse course forwards, in front and an inch to the inner side of the anterior superior spine of the ilium, and is thence continued parallel to Poupart's ligament and about one inch above it as far as its centre. If during the course of the exploration it is found necessary to obtain more room, the incision should be prolonged even as far as the external abdominal ring. This incision I have called the *lumbo-ilio-inguinal*.

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* *L'Union Médicale*, Février, 1856.

The structures divided.—The operation should commence at the loin, and the incision should be at once prolonged forwards to the front of the anterior superior iliac spine, and afterwards extended by degrees as required. The skin, superficial fascia, and fat having been divided, the border of the latissimus dorsi and the external oblique muscle are exposed, and divided to the full extent of the superficial incision. Then the internal oblique muscle, and at the back of the wound the fascia lumborum, are exposed and similarly divided to the full extent of the superficial incision. The last dorsal nerve and the subcostal artery and accompanying vein run along the lower border of the last rib, and usually escape being divided; but not unfrequently they pierce the lumbar fascia and take a lower course, and then they may cross the line of incision. If so, they are best divided, the artery being ligatured, and an inch or more of the nerve excised. If the last dorsal nerve pierces the muscular fibres of the transversalis after keeping along the lower edge of the last rib, instead of piercing the fascia lumborum, it will escape; but the lateral cutaneous branch of the last dorsal nerve, which pierces the external and internal oblique muscles and takes a downward course over the crest of the ilium, is necessarily divided. The trunk of the ilio-hypogastric nerve is usually below the line of incision, and is not seen; its hypogastric branch is lying parallel to the incision in front of the iliac spine and below it, and is not divided unless the incision is carried as far forwards as the external abdominal ring, where the nerve may be cut near its termination.

The fascia lumborum, and at the front of the wound some of the muscular fibres of the transversalis muscle, are divided to the full extent of the incision in the more superficial layers. This should be done very carefully, because in thin subjects the peritoneum is closely beneath the transversalis muscle, and very adherent to the intervening fascia. The outer edge of the quadratus lumborum is exposed, and if the muscle is broad it should be divided as far back as the limit of the skin incision.

The transversalis fascia will be exposed, and should be freely divided; the perinephric fat will then bulge into the wound at the back, and the sub-peritoneal fat be seen further forwards.

The search for the ureter.—The edges of the wound must be well retracted, and if the kidney has not been removed by a previous operation, and if it requires to be examined, it must be sought for now. This should be done in the manner ordinarily carried out in operations on the kidney. If the kidney need not be explored, it is sufficient to clear the surrounding fat from off the posterior surface of the renal pelvis with the forefinger nail, so as to bring it fairly into view, and to put the ureter into relief by traction.

If nephrectomy has not been previously performed, and if the perinephric tissue is not too much altered by inflammation, the renal pelvis, whether the kidney is to be explored or not, is the best starting-point for the systematic examination of the ureter. Following the inner border of the kidney upwards to the hilum, the finger reaches the angle between the kidney proper and the infundibulum, and if the tip of the forefinger be passed in front of this, the renal pelvis can be examined between the finger and thumb for any calculus or thickening in it; and, further, slight traction can be made upon the ureter by looping up the renal pelvis into the wound.

This done, the peritoneum should be detached gently with the finger-tips until the ureter is raised as far as the examination requires. With a thin flat sponge introduced into the wound the serous membrane and subjacent intestines should be drawn towards the middle line by the fingers of an assistant. Neither the sponge nor the assistant's fingers should be passed so far into the wound as to cover the peritoneum along the normal line of the ureter. If now the ureter can be brought into relief by gently pulling upon the renal pelvis, or if, without this, its outline can be distinguished on the detached face of the serous membrane, a few touches with the point of the scalpel will separate the surrounding cellular tissue and allow of the ureter being exposed. It must then be separated by careful dissection as far as the circumstances of the particular case require.

If it is desired to expose the pelvic section of the ureter, the incision of the abdominal parietes should be extended step by step by gently separating the peritoneum at the anterior extremity of the wound, and then with a probe-ended bistoury, guided upon the left forefinger, cutting the layers of fascia, muscles, and integuments from within outwards; or blunt-ended scissors may be used for this purpose. If the kidney has been removed, or perinephritis has occurred, and the tissues around the kidney are so condensed and adherent that the renal pelvis and adjacent ureter cannot be cleared, it will be necessary to commence the search for the ureter lower down, where it crosses the iliac vessels.

The ureter will be found upon the outer surface of the serous membrane, looking like a whitish or whitish yellow flattened tape. I have found it having this appearance, even when enlarged and so stuffed with tuberculous contents as to stand out like a rigid rod after being dissected away from its cellular tissue investment. In the male the ureter can be exposed and examined in this way without difficulty down to the bladder, and without the division of any blood-vessels or nerves from one end to the other. In the female the ureter is not so easy of access because of the broad ligament, the folds of which must be opened up; and as these folds, especially the posterior, descend very low into the pelvis there must be a considerable detachment of peritoneum. The peritoneum is moreover very thin and adherent to the structures in the pelvis, and therefore is easily torn. In the base of the broad ligament the ureter is surrounded by tough fibrous tissue, in which a plexus of minute vessels derived from the uterine and vesical arteries is contained.

In the male the spermatic vessels diverge from the ureter as the latter enters the true pelvis. In the female the ovarian vessels run in front of and close to the ureter for the first inch or two below the pelvic brim, and are sometimes so united with it by adhesions that it is difficult to isolate or even to recognise the ureter. The ovary itself is occasionally united with the ureter by adhesions or bands of false membrane. If the ureter has to be traced as far as the bladder, the uterine vessels which are in intimate relation with it—the artery in front, and the veins behind and crossing over it to reach its inner side—are in the way and must be divided and ligatured.

Several variations from the plan here described have been suggested or adopted, both as to the line of incision and as to the guides to be followed in seeking for the ureter.

As to the variations in the incision, they affect almost entirely the lumbar portion and for the most part are the same as are employed in performing operations on the kidney (*see* pp. 191 and 192, Vol. II.).

The vas deferens,* the spermatic vessels (Le Dentu), the psoas muscle and transverse processes and bodies of the lumbar vertebræ (Trekaki and Cabot), have been recommended as guides to the ureter; but they are all misleading, and surrounded with dangers which do not attach themselves to the method above described. It is unnecssary to do more than allude to them.

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* Regnier, *Bull. et Mém. de la Soc. de Chirur.*, Février 15, 1893, p. 107.

Other extra-peritoneal routes to the pelvic portion of the ureter.—Several methods have been proposed for reaching the terminal portion of the ureter, both in the male and female, without opening the peritoneal cavity. *In the male* five methods have been suggested, if not tried, viz. the rectal, hypogastric, sacral, perineal, and iliac or ilio-inguinal. In woman there are two chief routes, viz. the vesical and the vaginal, besides the sacral.

The rectal route.—Ceci * removed seven calculi from the lower end of the ureter by an incision through the rectum.

The hypogastric route.—The hypogastric route consists in opening the bladder above the pubes and examining the vesical orifice, then palpating and catheterising the intermural section of the duct. Albarran adopted this plan by making a transverse incision, and passed a retention catheter into the ureter. Glantenay states that in several instances at the Necker Hospital the longitudinal incision has been found to give ample room for exposing the ureteral orifices from above the pubes. Newman, Stanmore, Bishop, and Tuffier have each adopted this route in two or three cases for removal of stones from close to the mouth of the duct.

The sacral route.—Delbet recommended the method by means of an **L**-shaped incision, after the manner of Kraske for excision of cancer of the rectum; the soft parts are divided, the rectum laid bare, and the peritoneum reached, on the under or outer aspect of which the ureter is adherent.

Delbet's † directions for the sacral operation may be summarised as follows (Glantenay): (1) The patient should be placed upon his sound side, so that the rectum may fall away from the wound. (2) The incision should be **L**-shaped, with the long arm vertical, along the border of the coccyx, and the short falling upon the superior extremity of the first, being almost parallel to the fibres of the gluteus maximus. (3) Cut the insertion of this muscle and the sacro-sciatic ligaments and some fibres of the pyriformis. (4) Lay bare the lateral face of the rectum with forceps and a director. The ureter is always to be found adherent to the detached peritoneum, and can be followed downwards to the bladder and upwards for seven or eight cm. from its termination. This description applies specially to man; in woman the operation is more difficult because of the broad ligament.

Wölfler, for the removal of calculi from the inferior extremity of the ureter, advised a pararectal incision 10 cm. in length at 2 cm. from the median line. Regnier tried Wölfler's incision for ureterectomy of the lower end of the duct but failed to find it.*

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* *La Riforma Medica*, September 5th, 1867.

† Soc. Anatom., 1892.

Cabot and Fenger recommend resection of the sacrum for the purpose of gaining more room. Cabot thinks a modification of the incision of Kraske for excision of the rectum would open up the way to this part of the ureter (vesical end and near it); and Glantenay from his dissections confirms this.

Cabot † considers an incision the length of the sacrum stopping just below the coccyx, with division of the sacro-iliac ligaments, the removal of the coccyx and of the inferior portion of the side of the sacrum, opens the pelvic cavity in a satisfactory way, and gives easy access to the last three or four inches of the ureter. The only difficulty is the dissection with the view of finding the ureter, which is flattened and not easily recognised. The converging lines of the ureters as they cross the pelvis correspond, Cabot points out, almost exactly to the lateral border of the sacrum, and this relation may serve a little to determine their situation when one approaches them from behind. One can recognise and avoid wounding the rectum by passing a bougie into it and making it press outwards the side of the gut. This operation (sacrococcygeal) is unnecessarily severe, as Delbet's method gives sufficient room. Glantenay says he has practised both on the cadaver many times, and finds Cabot's a useless complication, which he thinks should be condemned definitely, having no advantages over the iliac route.

Cabot is of opinion that the last three or four inches of the ureter "practically cannot be reached by an extra-peritoneal route through an incision on the front of the abdomen"; but personal experience tells me that this is a mistake if he means it to apply to the male as well as to the female.

Author's operations by the sacral route.—In two cases, both women, in which I have removed calculi from the ureter in the living subject by the sacral route, I employed a straight incision parallel with the median line and one inch from it, five inches in length, commencing about two inches above the border of the gluteus maximus muscle and extending nearly to the transverse level of the anal aperture but a little behind it. The edges of the gluteus maximus and great sciatic ligament were divided and the rectum and vagina were pushed towards the opposite side by breaking through the cellulo-fatty tissue between them and the pelvic wall, by means of the forefinger and a few touches with the scalpel. In one of these cases the dorsal position, with the haunches well raised on a firm pillow placed beneath the loin, was found to facilitate the identification, isolation, and removal of the lower end of the ureter: in the other case the patient had to be turned upon her back before it was possible to fix the calculus. This was done by the forefinger in the vagina, and the patient was again placed on her opposite side with her face downwards and the calculus cut down upon and extracted.

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* *Bull. et Mém. de la Soc. de Chir.*, xix., 1893, p. 106.

† *Boston Med. and Surg. Journ.*, 1890.

Pre-rectal route.—To remove a stone impacted in the lower end of the ureter close to the back of the bladder in the male, an incision may be made similar to that which many years ago I demonstrated on the subject to be suitable for certain cases of prostatectomy, and which Ullmann of Vienna has successfully employed for excision of the vesicula seminalis. It consists of a crescentic incision, with the convexity backwards, about three-quarters of an inch in front of the anus from one tuber ischii to the other; and if more room is needed, joining to this incision another forwards along the raphe of the perineum. Then the rectum should be dissected from the prostate, this step being facilitated by a sound in the bladder: the fibres of the levator ani have to be divided so as to expose the prostate. Continuing the separation of the tissues upwards (which can now be done without the knife), the posterior extremity of the vesicula seminalis will be reached, and with it the ureter where it is passing between the seminal vesicle and the posterior wall of the bladder. Whilst separating the rectum from the prostate and vesicula seminalis, care must be taken, with the left index finger in the rectum and the right index finger in the wound, feeling from time to time for the sound in the urethra, to avoid wounding either the bowel or the urethra. Mr. Hurry Fenwick has employed this method successfully in one case.

The perineal route.—In 1884 I recommended that a calculus impacted at the vesical orifice of the ureter should be removed by opening the bladder through the perineum (*périnéal boutonnière*) in the male, or by dilating the urethra of the female, and, if necessary, incising the orifice of the ureter with a gum lancet-shaped knife in a long handle, passed along the index finger through the perineal opening or the female urethra as the case may be.* I did not however dream of suggesting this vesical method for calculi which had not actually reached the extremity of the ureter and could be there felt either by rectal examination or by sounding the bladder. So placed, however, a stone could be extracted through the bladder with fair certainty of not cutting its muscular and fibro-cellular coats. The peritoneum should be safe, because the intramural portion of the ureter passes between the mucous membrane and the muscular coat of the bladder, and thus a thick partition separates the impacted calculus from the dangerous area. Newman and Freyer † have extracted calculi from the ureteral orifices by these routes.

The ilio-inguinal.—In the male the ilio-inguinal is preferable to all the other routes. It is the same as the method previously described for tracing the ureter in its whole length, except that when the pelvic portion of the duct alone is sought the incision is limited to the anterior part of the abdomen, commencing above and to the inner side of the anterior superior iliac spine. Clinical experience has shown the suitability of this incision in the living subject.

Twynam,‡ instead of following this curvilinear line, made an incision as for tying the common iliac artery. Regnier § cut directly through the anterior wall of the inguinal canal, intending thence to follow the vas deferens as a guide to the ureter. This however failed, and he had after all to resort to the point of crossing of the iliac vessels and the ureter as a starting-point for tracing the duct into the pelvis.

In the female the rectal and perineal and the ilio-inguinal methods are out of the question.

Glantenay says the incontestable reasons which make the iliac route inferior in woman are the much greater difficulty in separating the peritoneum in consequence of the broad ligament; the dangers of serious hæmorrhages; the difficulty in applying hæmostasis at the bottom of the funnel-shaped recess; and the persistence of a cavity very disposed to urinous and purulent retention and infiltrations.

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* *Amer. Journ. Med. Sciences*, 1884, p. 468; also in "Surgical Diseases of the Kidney," 1885, p. 538.

† Mentioned by this surgeon in a communication to the Medical Society of London, but the cases are not published.

‡ *Trans. Clin. Soc.*, 1890, p. 93.

§ *Bull. et Mém. de la Soc. de Clin.* February, 1893, p. 107.

In woman there is much in favour of the sacral over the iliac route in seeking for the ureter in the pelvic part of its course. By the sacral route the ureter is more readily discovered if a ureteral catheter is previously passed, and this can be done in the female, whereas it cannot be readily employed in the male. All the difficulties which may arise from the relations of the ureter to the ovarian and uterine vessels, the broad ligament and ovary, are escaped by the sacral route. As the ureter passes across the pelvis in the base of the broad ligament it can be approached from the postero-inferior aspect without separating the folds of this ligament, and almost without separating the peritoneum from the pelvic wall. The uterine artery can also be easily avoided in approaching the ureter from behind and below, whilst the ovary and ovarian vessels are high out of the way. Again, if vessels have to be divided the bleeding ends can be easily seen and caught up, and the ligation is unattended by the difficulties of the iliac way.

The *vesical* method would be the simplest and readiest for a stone impacted at the vesical orifice of the ureter. It would be easy after dilating the urethra, and incising if it were necessary the ureteral orifice whilst the calculus was steadied by the finger of the left hand in the vagina, to set free a calculus and remove it through the urethra.* Nathan Bozemann opened the bladder *through the vagina* with a view of treating suppuration in the renal pelvis by irrigation along the ureter.† Others have commended the vesical method by the hypogastric route, in preference to that by the vaginal or urethral, for operating upon the terminal extremity of the ureter.

The *vaginal method* is adapted only for plastic operation on the last part of the ureter, and for calculi impacted in the vesical and juxta-vesical part. It has the sanction of experience, and has yielded admirable cures for uretero-vaginal fistulæ. It has been adopted by Emmet, by Cabot, and by M. Doyen. M. Doyen, without having previously felt the calculus, made a deliberate incision into the vagina, and then detected and excised the stone through a sub-peritoneal incision in the ureter. Emmet and Cabot in their cases felt the calculus through the vagina wall before commencing their operations, and therefore took the stone for their guidance in making their incision into the ureter.

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* See Morris, *Amer. Journ. Med. Sciences*, October, 1884.

† *Amer. Journ. of Medical Sciences*, March and May, 1888, p. 255.

Doyen's operation is superior to Emmet's and Cabot's in so far that it enables the surgeon to extend his examination to the whole of the juxta-vaginal and broad ligament portions of the ureter, and thus to find and extract a stone situated at a height at which it could not be felt by simple vaginal palpation. By the use of retractors the field of operation in the vagina can be enlarged so as to some extent to facilitate the difficult manipulations for suturing the ureter. The ureter is to be exposed at the level of the *bas fond* by an incision of the anterior *cul-de-sac* of the vagina, practised as in vaginal hysterectomy. The neck of the uterus is seized forcibly and dragged downwards and backwards so as to make tense the *cul-de-sac*, and the mucous membrane of the vagina in front of the uterus to its full width is incised. This done, the bladder should be separated as far up as the vesico-uterine *cul-de-sac* with the finger. If the walls of the ureter are thickened by tuberculous deposit, or by ureteritis, or distended by a calculus, or made evident by the ureteral catheter, there is no difficulty in its discovery. Otherwise there is no certainty of finding it. But practically this difficulty will not commonly exist, because before adopting the vaginal method there has ordinarily been found by digital examination *per vaginam* evidence of some distinct lesion of the tube. An abnormal condition of the ureter felt before beginning the operation is itself the guide to the duct. The operation is terminated by inserting a strip of iodoform gauze as a drain for the vaginal *cul-de-sac*.

A comparison of the sacral and vaginal routes shows that the *sacral* conducts directly to the posterior segment of the pelvic portion of the ureter; the *vaginal* leads to the anterior part. The sacral way permits the examination of the whole of the pelvic part of the ureter; the vaginal route allows of the palpation of the ureter within and in front of the broad ligament nearly if not quite up to the brim of the pelvis, but the vaginal method gives little room for the use of fingers and instruments during an operation. The distance between the ureter and the pelvic wall at the level of the cervix—in the middle of which interval the ureter courses—is only 4 cm., a space far too narrow to permit the manipulation necessary to operate upon the ureter as far up as the neighbourhood of the brim of the pelvis.

The vaginal method is the best for calculi situated in the juxta-vaginal portions of the ureter; but the sacral route is greatly superior for the rest of the pelvic part in the female.

CHAPTER XV.

PLASTIC OPERATIONS ON THE URETER.

Besides the operations of ureterotomy, re-section of a part of the ureter, and ureterectomy, many others have been performed upon, and more still have been suggested as applicable to the human ureter. Many of them, however, have up to the present only been experimentally attempted on the lower animals; but experiments prosecuted with great industry and technical ingenuity and skill have succeeded in placing several others on a firm practical footing as recognised surgical operations.

The following is a classified list of the operations which are performed upon the ureter. The indications for these operations will be mentioned under the several classes:—

I. **Operations which restore the continuity of the renal pelvis with the ureter; or the cut ends of the divided ureter with one another.**—A. *Pyelo-ureteral anastomosis* or *pyelo-ureterotresis, i.e.* the implantation of the ureter at a new point of the renal pelvis.

B. *Uretero-ureteral anastomosis, i.e.* joining the divided ends of the ureter to one another. There are four different methods:

(*a*) The end to end.

(*b*) The end in end.

(*c*) The lateral anastomosis.

(*d*) The oblique end to end.

C. *Anastomosis after re-section of a portion of the ureter.*

II. **Operations which directly re-establish a connection between the ureter and the bladder by grafting the ureter into the bladder.**—A. Abdominal methods. (1) Trans-abdominal retro-peritoneal *cysto-ureterotresis,* by which the proximal end of the ureter is dissected free and approximated to the bladder through the peritoneal cavity, but sutured to the bladder outside the peritoneum.

With this method may be associated a case by Israel, in which the ureter was grafted to the bladder through the lumbo-ilio-inguinal extra-peritoneal route, and a few cases in which the ureteral grafting has been accomplished through the bladder by means of supra-pubic cystotomy.

(2) Intra-peritoneal *cysto-ureterotresis.*

B. *Kolpo-cysto-ureterotresis, i.e.* deflecting an abnormal ureteral orifice from the vagina into the bladder through the vesico-vaginal septum. There are many ways by which this has been done, but they may be grouped under the two following heads:—

(*a*) Grafting the entire fistulous orifice into the bladder.

(*b*) Obliterating the fistulous orifice after making a new communication between the end of the ureter and the bladder.

These operations are performed for uretero-vaginal or uretero-uterine fistulæ; as well as for congenital abnormal openings into the urethra or vagina. They are suitable in certain cases of injury inflicted during vaginal hysterectomy.

III. **Operations for directing the urine immediately to the surface of the body.**—*Dermato-ureterotresis, i.e.* fixing the cut end of the proximal part of the ureter to the skin. This necessarily forms a fistula, which may be established either in the lumbar region or on the lateral or anterior aspect of the abdomen.

IV. **Operations for directing the urine into the bowel.**[*] —A. *Entero-ureterotresis, i.e.* grafting the ureter into the small intestine.

B. *Colo-ureterotresis, i.e.* grafting the ureter into the colon.

C. *Procto-ureterotresis, i.e.* grafting the ureter into the rectum.

V. **Operations for restoring the course of the urine to the bladder through the medium of some form of "splice"** to make good a deficiency in the length of the ureter.

A. *Entero-cysto-ureterotresis, i.e.* making good a short length of the ureter by grafting its divided ends into a piece of small intestine previously detached from the rest of the bowel.

B. *Dermo-cysto-ureterotresis, i.e.* making good a short length of the ureter by grafting both ends of the divided ureter as near as possible to one another on the abdominal wall and connecting them by a tunnel of skin or connective tissue.

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[*] Gaspare d'Urso and Achille de Fabii, who have recently published (*Annales des Maladies des Organes génito-urinaires*, Nov., 1900) an account of their experiments on animals, propose the term "*Uretero-etero-plasty*" for the operations of grafting the cut end of one ureter into the intestines, or into the opposite ureter, or the bladder.

C. *Cysto-cysto-ureterotresis, i.e.* by making good a short length of the ureter by means of a splice which is converted into a tunnel out of the bladder wall itself.

VI. **Ureterotomy and pyelotomy.**

VII. **Ureterectomy.**—This may be partial or complete, primary or secondary. *Primary* when performed at the same time as the kidney is removed; it is then called *nephro-ureterectomy.* Secondary when done some time after the kidney has been removed.

URETERAL ANASTOMOSIS.

URETERO-PLASTY, OR PLASTIC OPERATIONS ON THE URETER.

The plastic operations include (1) the grafting of the ureter to the renal pelvis, "pyelo-ureterotresis"; (2) a variety of means of anastomising the divided ends of the ureter, "uretero-ureteral anastomosis"; and (3) a variety of methods of grafting the end of the ureter into the bladder or bowel, or upon the surface of the body, "ureteral grafting," either as a final result or as a step towards restoring continuity with the bladder.

A. PYELO-URETEROTRESIS WITHOUT RE-SECTION OF ANY PART OF THE URETER.

Pyelo-ureterotresis may be performed either without re-section of any part of the ureter or after partial ureterectomy to the extent of one, two, or three inches of the duct (*see* Section C, p. 553).

Description of the operation.—The kidney and upper part of the ureter are exposed in the ordinary manner through the lumbo-iliac incision. The kidney will be found hydro-nephrotic or pyo-nephrotic, with in great probability a disproportionate distension of the renal pelvis in comparison with any other change there may be in the organ.

In many cases the body of the kidney, though possibly soft and flaccid, will not be increased in size, but the renal pelvis will be distended to a size varying from a Tangierine orange to a rock melon or larger. Assuming that there is no question of calculus, in which case it will not be requisite to incise the convex border of the kidney, an incision 1 cm. or less in length should be made in a vertical direction in the back of the renal pelvis (Fig. 177). Through this a bougie should be passed and the position and nature of the upper orifice of the ureter should be made out. If this is abnormal, but such as can be remedied by one of the methods of pyelo-ureterotomy described in the chapter on "Ureterotomy" (*see post,* p. 615), this should be done. Possibly the small incision in the renal pelvis already made may, if prolonged, be convenient for laying open the renal pelvis to its lowest point, and the defective ureteral orifice may in this way perhaps be corrected (*see* Figs. on p. 437, Vol. II.). If not, re-section of the upper end of the ureter should be proceeded with. The ureter should be divided quite close to its attachment to the hydronephrotic infundibulum, and again at a suitable point lower down, but so as to leave the ureter long enough to be sutured to the sac without any tension on either. The detached end of the duct should next be dissected free for a short distance from the connective tissue, and then a longitudinal incision $1\frac{1}{2}$ cm. long should be made from the cut end downwards in the axis of the tube. The corners of the incised edges of the ureter may, if thought best, be rounded off. This is for the purpose of making the mouth of the ureter wide. Another way of seeking the same end is by cutting the ureter obliquely, as suggested by Bovée. The next step is to divide the wall of the hydronephrotic infundibulum from the point of

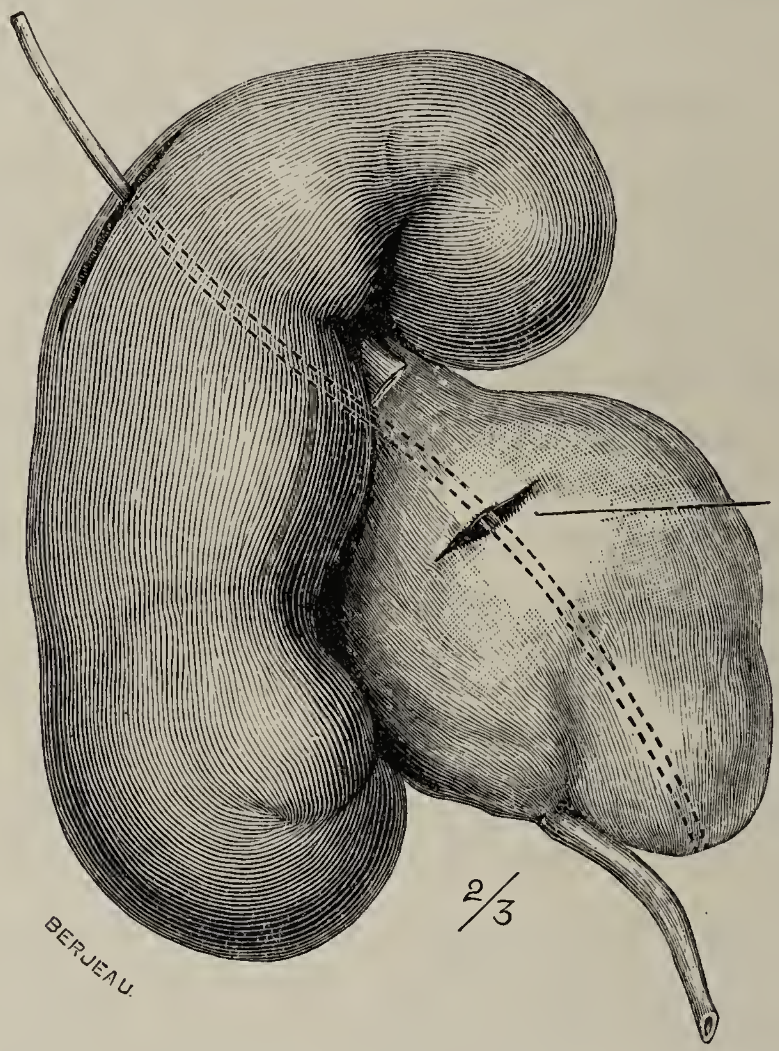
Incision in back of renal pelvis through which the bougie was passed into the ureter, as it could not be made to enter the ureter through the body of the kidney. It is better to make this incision longitudinally, instead of in the transverse direction shown in the figure.
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Fig. 177.—Abnormal position of Ureter to Hydro-nephrotic Infundibulum of Kidney before operation. (Author's case.) "Hunterian Lectures," Table VI., No. 17, and pp. 23 and 24.

original insertion of the ureter down to the lowest point of the sac, at which part it is intended to make the new insertion of the ureter. This done the ureter is to be sutured to the margins of the lowest part of the incision in the infundibulum by several fine silk sutures, and afterwards the rest of the wound in the infundibulum is to be closed in the same way. If the incision of exploration in the renal pelvis is distinct from the operation incision, this also must be closed by fine silk sutures (*see* Figs. 177 and 178, and Fig. 199, *post*, p. 621). The best stitch is Lembert's, passed so as not to penetrate the mucous membrane.

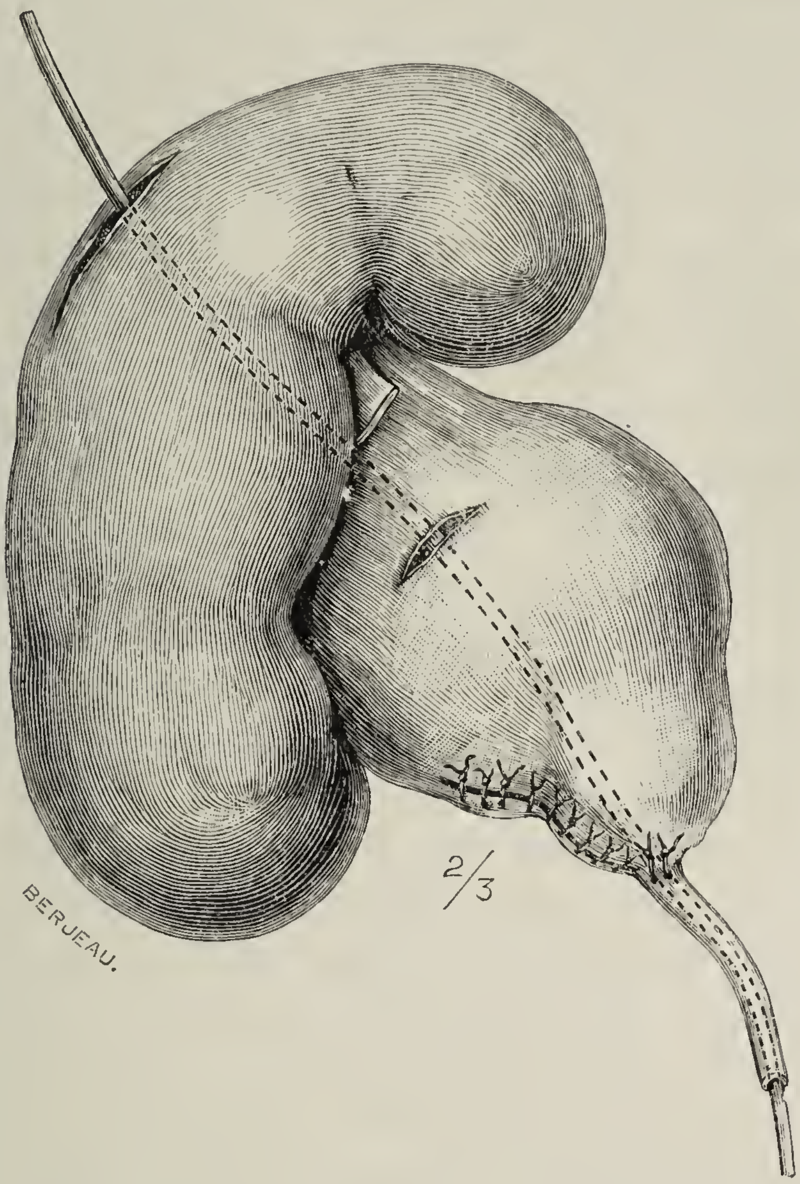

Fig. 178.—Ureter in its improved position to the infundibulum after re-section of the upper end of the ureter and its reunion with the renal pelvis. From the same as Fig. 177.

If a stricture exists an inch or two below the top of the ureter, the ureter must be divided immediately below the stricture, as was done by Küster. If more than three inches have to be removed to get below an elongated obstruction which, though somewhat interrupted, is more or less in continuity with the renal pelvis, pyelo-ureterotresis must be abandoned and nephrectomy or lumbar-dermato-ureterotresis, according to circumstances, must be substituted for it, unless indeed the kidney is very movable, or easily displaced to and fixed in a position low enough to enable the end of the ureter to be grafted to the infundibulum without undue traction. Any stricture or valve in the upper end of the ureter not immediately involving the upper orifice should of course be treated by *ureterotomy* if the ureteral orifice is of normal shape and position; or if ureterotomy is unsuitable because of the length of the ureter which is stenosed, the affected part must be removed without interfering with the renal pelvis, and the divided ends brought together by *ureteral anastomosis.*

The operation on the uretero-renal tissues being completed, the lumbar wound should be closed, leaving a drainage tube communicating with the area immediately surrounding the kidney.

The catheter *en demeure* is unnecessary, as there is very little fear of stricture at the line of union following a properly effected pyelo-ureterotresis, if the ureter is of good normal calibre. If immediate union should fail, and a urinary fistula form, the fistula may be expected to be only temporary if efficient drainage is maintained. In *uretero-plasty* experience shows that it is very improbable that stenosis at the seat of operation will occur whilst repair is actually going on; the dangers are (1) failure of good repair and, as a consequence, extravasation of urine as soon as the sutures work through the tissues; and (2) stenosis at a later date, from contraction of the cicatrix.

The anatomical conditions under which this operation has to be performed are more favourable than those of uretero-ureteral anastomosis. The renal pelvis being so much wider, it is easier to insert sutures; and cicatricial contraction is not likely to cause secondary destructive changes in the kidney.

Indications for the operation.—Pyelo-ureterotresis is indicated under the following circumstances:

If a portion of the upper end of the ureter has been cut out by accident during an operation; for stricture, for ulceration around a calculus, for valve; for constriction by an abdominal renal vessel; or when the kidney is hydro-nephrotic, and the ureter is adherent to, and comes off at a point of the hydro-nephrotic sac too high to allow its carrying away the urine, which collects in the renal pelvis (*see* Figs. on p. 436).

Precautions in connection with operation.—In performing re-section, as also in the operations for the anastomosis of the cut ends of the ureter, we must not compress the cut edges with forceps to prevent escape of urine, for fear of causing sloughs. If forceps are used they should be placed at the extreme edges of the wounded parts, and the compressed ends should be removed before suturing, so that the sutures will be carried through tissues of good vitality and integrity. It has been suggested that the sutures should be introduced over a catheter *en demeure,* the end of which is carried out of the urethra through the bladder; and this procedure is strongly advocated by a few surgeons who have tried it in ureteral anastomosis. It is however not to be recommended; excellent results are obtained without it, and there is always the risk of the catheter becoming encrusted with salts, or breaking off in the ureter.

Pyelo-ureterotresis ought to replace nephrectomy in certain cases of renal distension and renal fistula due to obstruction from stricture or valve near the infundibulum.

Further remarks are made upon pyelo-ureterotresis under "Re-section of the Ureter" at the end of this chapter (p. 553).

Other operations have been suggested as alternatives in cases of too great obliquity of the uretero-renal orifice.

1. The lateral anastomosis of the ureter to the renal pelvis without complete division of the ureter, and therefore in a manner very different from Van Hook's lateral plan of uretero-ureteral anastomosis. The renal sac is incised at its lowest part, and a longitudinal incision is made in the ureter opposite to and on the level with this incision in the infundibulum. The margins of these two small wounds are then sutured to each other, the anterior and the posterior margins respectively. This operation would do well for cases such as that illustrated in Fig. 177; but not where there is an annular stricture of the ureter below the level of the sac or renal pelvis.

2. Israel has performed an operation whereby the ureteral orifice was brought to the lowest part of the infundibulum by plicating the hydro-nephrotic sac and thus obliterating the portion below the ureteral orifice.

3. Albarran speaks of what he calls the *re-section orthopédique* of the kidney. This operation consists in cutting away the portion of the kidney below the level of the junction of the ureter with the kidney. In the case in which he adopted this plan, he at the same time also divided the diaphragm in the uretero-renal aperture merely to enlarge it; the re-section of

the lower end of the kidney made the orifice dependent. Figs. 159 (p. 425) and 163 (p. 436), and several others contained in these volumes, show that to carry out this plan three-quarters at least of the kidney would in some cases have to be sacrificed.

With the other plans at our command there is nothing to recommend an operation attended by the sacrifice of a portion of the kidney itself.

B. URETERO-URETERAL ANASTOMOSIS.

Four methods, as we have seen, have been successfully employed for joining the ends of a divided ureter:

1. The end to end union.
2. The end in end anastomosis.
3. The lateral *implantation* method of Weller Van Hook.
4. The oblique end to end anastomosis.

History of the operation.—By each of these methods good results have been obtained upon the human ureter.

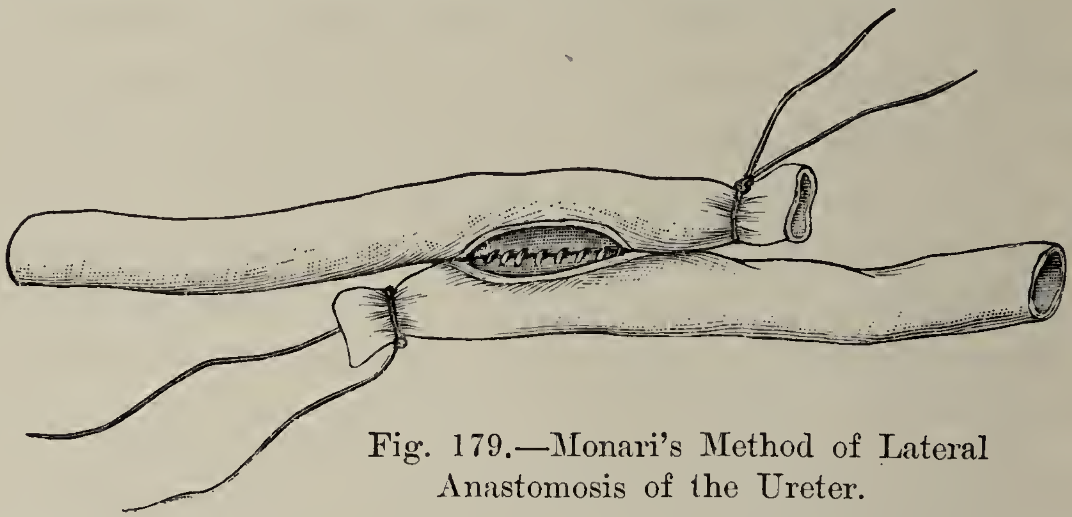

Fig. 179.—Monari's Method of Lateral Anastomosis of the Ureter.

The latero-lateral *anastomosis* of Monari* has commended itself to some who have experimented upon animals; but has never, I believe, been employed on man. Fig. 179 indicates this operation.

D'Urso and Fabii have simplified Monari's method by making the linear incisions into the two parts of the ureter upon bougies introduced into them for a distance of about 3 cm., and suturing the respective margins of these incisions together before withdrawing the bougies. This done the cut ends of the ureter are tied in a special manner. First, the ureter is surrounded by a ligature near the spot at which the bougie was tied into the tube; then the same ligature is tied over the free end of the ureter, thus giving the cut end of the duct a bicornate appearance. The ends of the ligature are next tied successively around each horn, and finally around both horns of the end of the ureter (*see* Fig. 180).

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* Umberto Monari, "Uretero-anastomosi: Ricerche sperimentali," Bologna, 1895.

Various surgeons, feeling how unsatisfactory were the results hitherto obtained by many of the methods of ureteral grafting, and that healthy kidneys were unnecessarily being sacrificed on account of ureteral injuries when treated by ligature or nephrectomy, attempted to unite the divided ends of the ureter together. Attempts by experiments on animals were first made to unite the cut end of the ureter over a gum elastic catheter by Gusserow and Pawlik; but final closure was not accomplished in any except by Pawlik on one occasion, and even in that case the wound re-opened after withdrawing the catheter *en demeure,* which had become encrusted with salts.

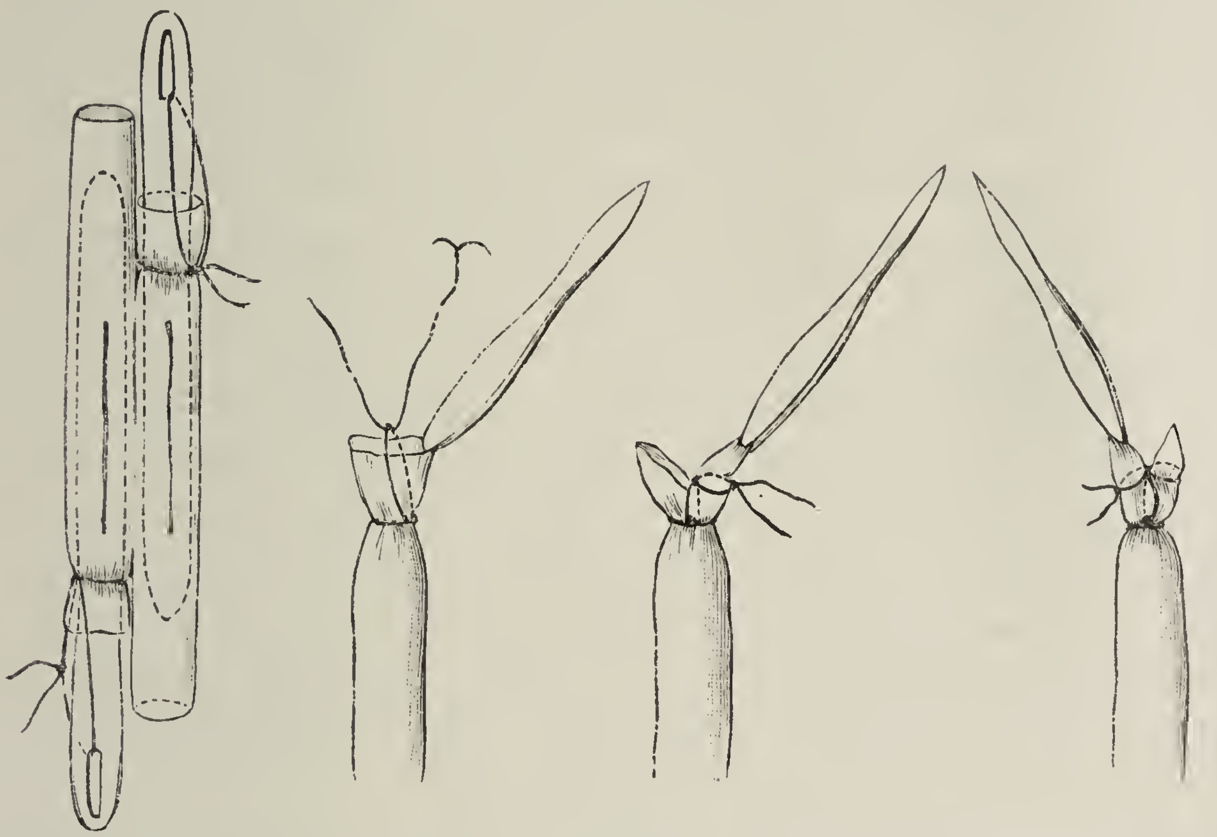

Fig. 180.—D'Urso's and Fabii's adaptation of Monari's Method for Lateral Anastomosis of the Ureter.

Then came Schopf's case in the human subject, reported in 1886; next Tuffier's experiments in 1889; and Cushing's case in 1893, which was the second time the *end to end* method was employed on the human subject. Poggi's experiments of the *end in end* method were published in the *Riforma Medica* in 1887. Then came Van Hook's *lateral method,* and Kelly's application of it to women (May, 1892), which was reported in October, 1893. Emmet's case (November, 1894), the second in which Van Hook's operation was done was published in April, 1895. Later, on a human being, an account by Bovée of the operation, performed by himself, in 1895, was published in January, 1897, together with an admirable *résumé* of the whole subject of uretero-ureteral anastomosis.*

Conditions requiring uretero-ureteral anastomosis.—Uretero-ureteral anastomosis is applicable under the following circumstances:—

(*a*) To restore the continuity of the duct after accidental division during abdominal operations.

(*b*) After deliberate division or removal of some small portion of the duct in abdominal operations. Bovée says an inch or two, but not more than three inches, may be removed and yet the ends afterwards can be brought together. This is explained by the fact that the ureter measures two or three inches longer when dissected out of its connective tissue bed than when *in situ:* and that the retraction of the ends caused by the longitudinal muscular coat when the ureter is cut across can be easily overcome. Considerable traction upon these ends is consistent with their efficiency when united. The traction should be steadily continued for some time in order to overcome muscular resistance; as the blood supply is free and the vessels are tortuous there is little fear of sloughing. If the kidney be movable, and can readily be brought down and kept at a lower level in the loin than its normal position, the loss of a much greater piece of the ureter would be compatible with pyelo-ureterotresis, or uretero-ureteral anastomosis than otherwise.

(*c*) After re-section of a portion of the ureter for stricture; for the contraction which follows ulceration and sloughing of the mucous membrane about an impacted calculus; or for any other condition which if left unremoved would terminate in stenosis.

(*d*) After rupture and some other injuries of the ureter from external violence—whether intra-peritoneal or retro-peritoneal.

B.—1. *End to end anastomosis by suturing the ends together in a transverse line.*—This has been done in several ways. Schopf (June 2nd, 1886), after proving that the ends were patulous by the passage of a sound and dissecting them up for a short distance free from the surrounding tissue, freshened and approximated them by eight silk sutures passed through all but the inner coat; no urine then escaping at the joining, the toilet of the peritoneum was completed and the abdomen closed. The catheter was passed into the bladder every four hours. The patient recovered from the operation, but died seven weeks after from tuberculosis. The union of the ureter was found embedded in a mass of cicatricial tissue. Schopf was dissatisfied with the result.

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* Wesley Bovée, *Annals of Surgery*, Jan., 1897, and July–Dec., p. 314.

Pawlik (July 6th, 1888) sewed the ends together over an elastic ureteral catheter with silk (Lembert) sutures in two planes and closed the peritoneum over it.

Tauffer (*see* Bovée's paper) placed a piece of English catheter, No. 8, into the divided ends of the ureter. He used six or eight sutures, and removed the catheter before tying the last three knots. The abdomen was drained; the patient was cured. Tauffer is the only operator who has had two cases as yet.

Fritsch seems to have simply brought the ends together with "fine intestinal suture." The parts healed perfectly.

Julius Hochenegg, in the course of a sacro-peritoneal extirpation, deliberately divided the ureter, which was at once sutured end to end. The patient died on the twentieth day of hæmorrhage connected with the original operation, during which the ureter was wounded. At the autopsy the ureteral joining was satisfactory, the sutures being intact.

Cushing of Boston, having found the ends of the cut ureter, united them by two fine sutures of silk and one of catgut; he employed drainage. There was discharge of a little urine from the wound for some two weeks, but the fistula promptly closed; in this case both ureters were distended and tortuous. The patient was alive and well two years later.*

The objections which have been raised to the end to end method are, that the walls of the ureter are too thin to bear sutures; that if one uses catgut it is too quickly absorbed; and if silk it forms a foundation for concretions. But better reasons than these are that perfect co-aptation is difficult; that leakage is probable; and that stenosis is almost sure to follow, either from the cicatrix in the line of union, from compression from without by condensed cellular tissue, or from folding in of the mucosa.

B.—2. *The end in end anastomosis.*—The end in end invagination of the upper into the lower portion of the ureter is the method of Poggi. Poggi originated this method in experiments on dogs with eminently successful results.

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* *Annals of Gynæcology and Pediatry*, vol. vi., February, 1893, and referred to by Bovée and by Emmet (*Amer. Journ. of Obstetrics*, 1895, xxxi., pp. 459–460).

Poggi* invaginated the upper divided end of the ureter directly into the inferior. To do this he dilated the inferior to the extent of about 1 cm., then he took a catgut suture armed with a needle at each end. One needle was passed into the lumen of the lower end, and brought out through its walls a centimetre lower down. The other needle was similarly passed through the wall of the superior end some millimetres from its cut end; this second needle was then passed into the lumen of the lower end, and made to pierce the wall of the inferior segment of the ureter a few millimetres below the cut end, and therefore at a point above the track of the first needle (Fig. 181). A similar suture, similarly armed with two needles, was introduced on the opposite side of the ureter. The ends of the sutures were now drawn upon, and thus the upper end was drawn into the lower end of the ureter, and fixed there by tying each suture separately in a knot.

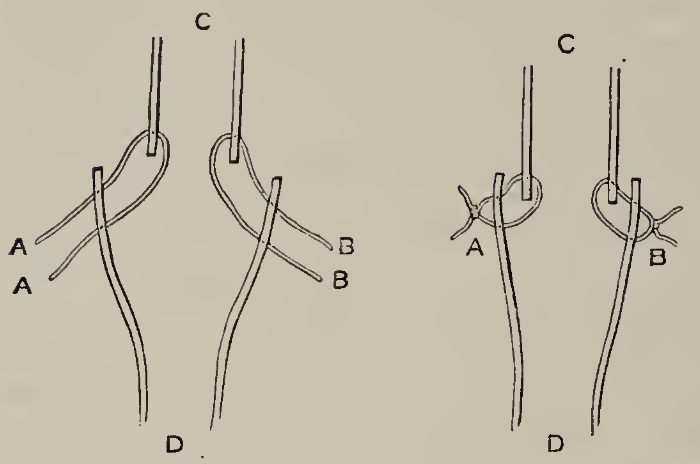

Fig. 181.—Poggi's Method by direct Invagination. Seen in section. (*Archives Provinciales de Chirurgie*, vol. vi., June 1, 1896.)

A A, B B, Sutures; C C, superior end; D D, inferior end.

Mayo Robson † adopted the end in end method on the human ureter by splitting the lower end, and drawing the upper into it. Winslow also has successfully adopted the end in end method by means of a suture threaded with two needles, which were passed from the outer surface into the lumen of the uppersegment, and from the lumen out on to the outer surface below the split in the lower segment.

B.—3. *Lateral implantation by the method of Van Hook for uniting the ureter after transverse division.*—This operation consists briefly in the implantation of the upper cut end of the tube into an opening in the side of the lower end. The technique as described by its originator, W. Van Hook,‡ is as follows:—

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* "Chir. des Urétères Thesis," Paris, 1895, p. 293; "Guérison immediate des Sections transversales des urétères sans obliteration de leur cavité. *See* also *Riforma Medica*, 1887–1888, N. S., viii., 39.

† Mayo Robson, *Inter. Med. Ann.*, 1896, p. 602.

‡ Van Hook, *Journ. of the Amer. Med. Assoc.*, 1893, xx., p. 225; 1893, xxi., pp. 911 and 965.

(*a*) Ligate the lower portion of the tube one-eighth or one-quarter of an inch from the free end. Make with fine sharp-pointed scissors a longitudinal incision twice as long as the diameter of the ureter in the wall of the lower end, one-fourth of an inch below the ligature.

(*b*) Make an incision with the scissors in the upper portion of the ureter, beginning at the open end of the duct and carrying it up one-fourth of an inch. This incision insures the patency of the tube.

(*c*) Pass two very small cambric sewing needles armed with one thread of sterilised catgut through the wall of the upper end of the ureter one-eighth of an inch from the extremity from within outwards, the needles being from one-sixteenth to one-eighth of an inch apart, and equi-distant from the end of the duct. It will be seen that the loop of catgut between the needles firmly grasps the end of the ureter.

(*d*) These needles are now carried through the slit in the side of the lower end of the ureter into and down the tube for half an inch, where they are pushed through the wall of the duct, side by side.

(*e*) It will now be seen that the traction upon this catgut loop passing through the wall of the ureter will draw the upper fragment of the duct into the lower portion. This being done, the ends of the loop are tied together securely, and, as the catgut will be absorbed in a few days, calculi do not form to obstruct the passage of the urine.

(*f*) The ureter is now enveloped carefully with peritoneum. This may be done by lifting the duct gently into the cavity of the peritoneum, drawing the serous membrane carefully behind the ureter, and after pulling the peritoneum around it, stitching it in a position to permanently enclose and protect the tube. Or the ureter may be surrounded in a completely detached fold of omentum, which is loosely attached by a stitch to the connective tissue about the duct. The omentum method is less secure than the other, since the omentum is deprived of its blood supply.

Van Hook developed his operation in experiments on dogs, and Kelly* first successfully applied it to the ureter of a woman. Bloodgood tested it on a large dog, which he killed at the end of two and a half months and found the kidney normal, the ureter not dilated above the seat of operation, and the calibre and mucous membrane at the seat restored without stricture.

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* *Bull. of the Johns Hopkins Hospital*, October, 1893, p. 90.

Howard Kelly of Baltimore, B. Emmet of New York, and Doherty of Georgia,* have successfully carried out Van Hook's operation on the human ureters.

Emmet slightly modified Van Hook's method by using three sutures instead of one, because the upper portion was very much distended, and had to be puckered to get it into the lower portion, which was only half the size of the upper, owing to the ureter having been cut just where the tumour had pressed upon it. He also employed continuous suturing between the edges of the slit and the upper section of the ureter (Fig. 183).

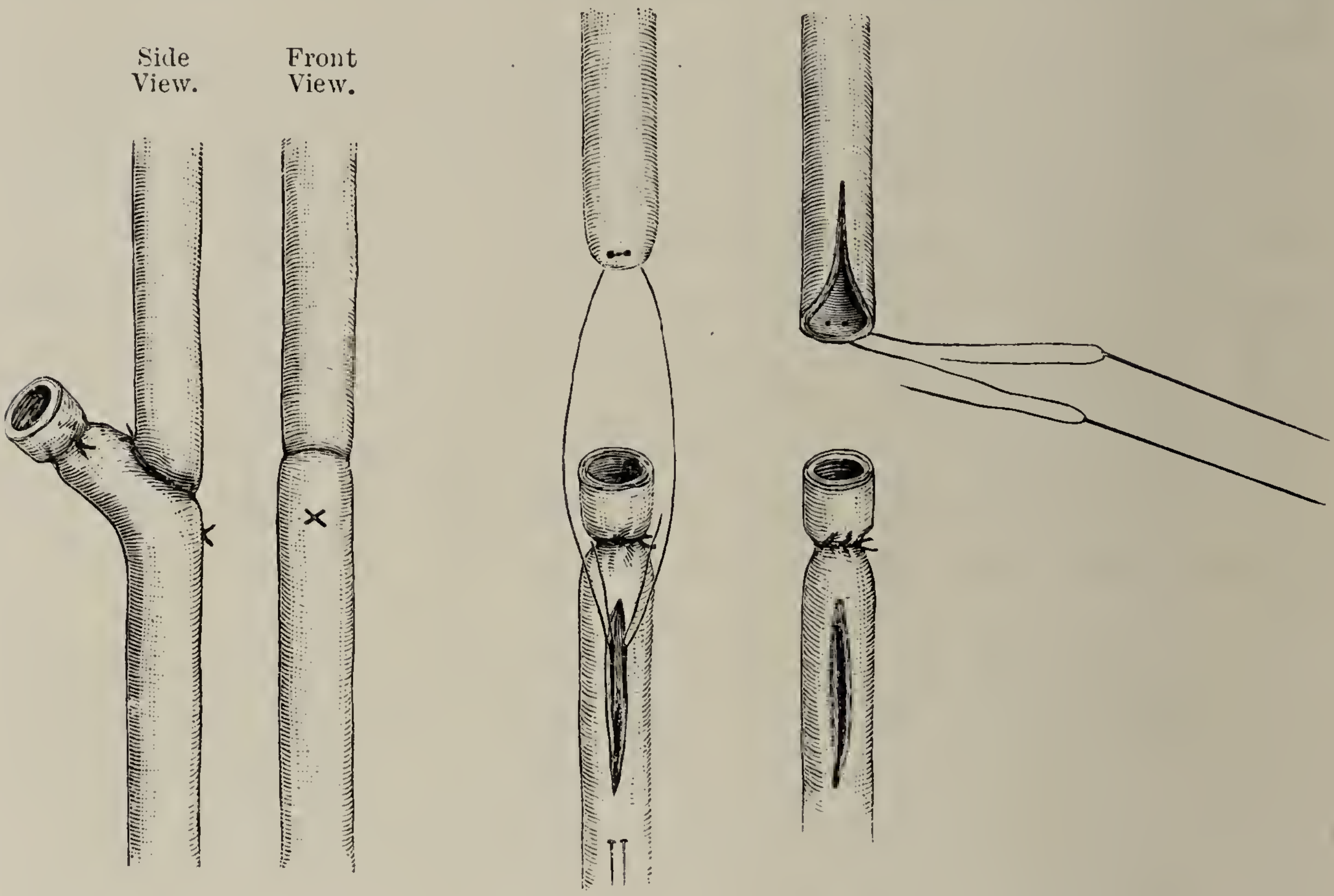

Fig. 182.—Van Hook's Method of Uretero-ureteral lateral infiltration.

In Kelly's case, "as a result of pressure from the uterine myoma, the ureter was enlarged to four times its normal circumference, forming a well marked hydro-ureter." The operation therefore was much easier than it would have been on a normal duct. Kelly, whilst proceeding according to Van Hook's method, used only a single needle carrying a fine silk suture, and commenced by passing it "through the lateral wall of the lower portion a half centimetre below and posterior to the angle of the slit, and brought it out through the slit, and caught it in the outer coats of the upper end of the ureter close to its margin; this suture was then carried back into the slit, and through the wall of the ureter close to the initial point of entrance. A similar suture was then passed at a point directly opposite. By making traction on these sutures while holding the slit open the upper end of the ureter was readily invaginated into the lower. These sutures were then snugly tied." Ten fine silk rectangular sutures catching only the outer coat then united the edges of the slit in the lower part of the tube to the intussuscepted portion.

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* Private communication to Weller Van Hook. See *Journal of the Amer. Med. Association*, November 16, 1895, p. 843.

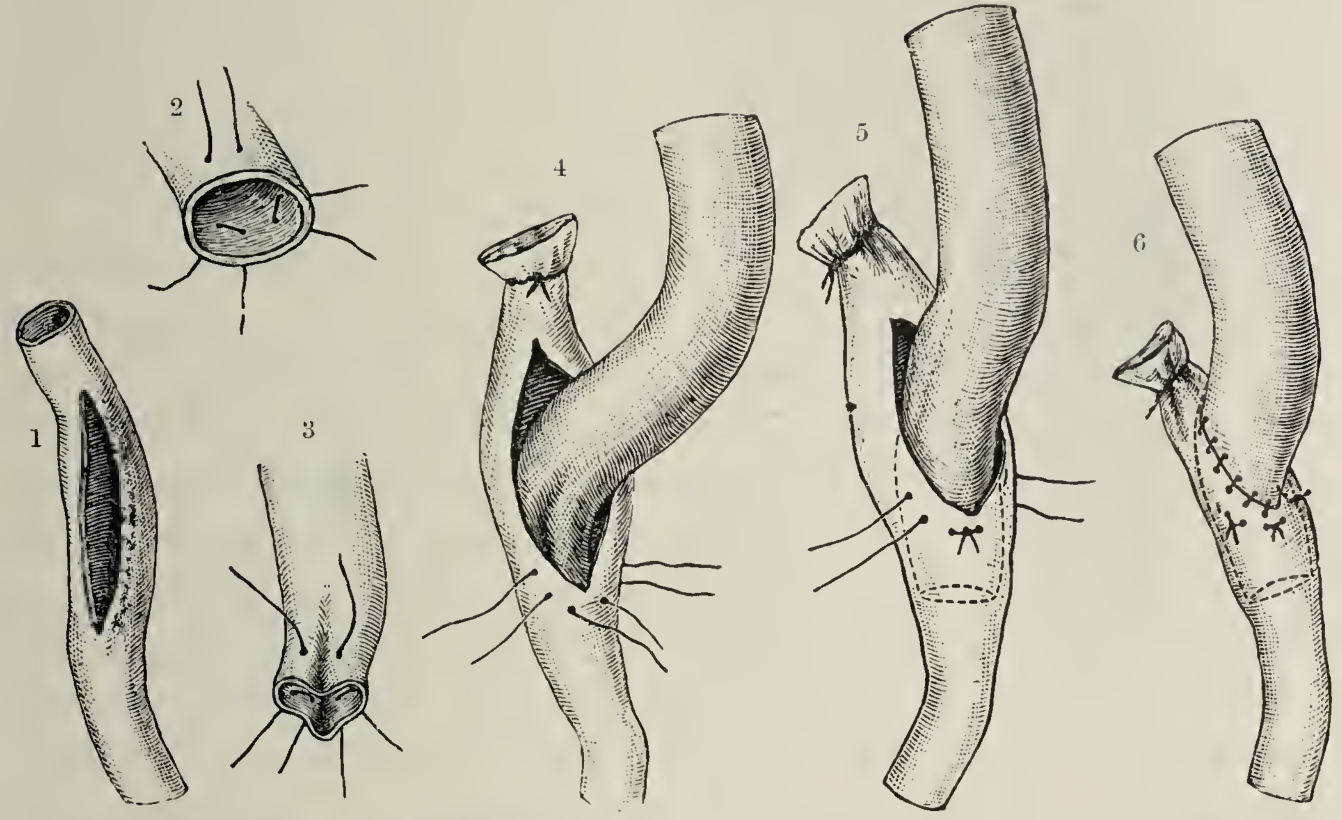

Fig. 183.—Emmet's modification of Van Hook's Method. (*American Journal of Obstetrics*, vol. xxxi., April, 1895.)

Fig. 1.—The lower portion of ureter artificially stretched. Fig. 2.—Three double sutures in upper segment. Fig. 3.—Upper segment crinkled ready for insertion into lower segment. Figs. 4 and 5.—Upper portion drawn into the lower. Fig. 6.—Edge of slit stitched to the upper section of ureter by continuous suture.

I have in one case resorted to Van Hook's method of lateral anastomosis but without success, as the ureter was very thin and small and the healing process was defective. Extravasation of urine into the lumbar cellular tissue occurred on the eleventh day, and nephrectomy had subsequently to be performed.

The patient was a single woman, phlegmatic and very delicate, aged thirty, both of whose kidneys were very movable. She had suffered a great deal from this cause for three and a half years. The left kidney was fixed by Vulliet's method on the 18th January, 1899; there was nothing abnormal about the appearance of this organ; the ilio-costal wound healed rapidly throughout. The small vertical wound through which the tendon of the longissimus dorsi was detached did not quite heal up till a small fragment of necrosed tendon separated. On the 20th February, 1899, nephropexy on the right side was performed; as soon as this kidney was exposed it was seen to be very small, an appearance in part real but in part due to the fact that it was much deformed, being so bent upon itself that the inner borders of the two poles of the kidney were nearly approximated. In addition there was a quantity of thick and dense fibrous tissue firmly adherent to the lower part of the kidney, and as it turned out the ureter was involved in this tissue. Instead of descending from the hilum in the normal way, the ureter curved outwards round the lower part of the kidney so as to make a very perfect sigmoid curve reversed (*see* Fig. 184). These adhesions, being localised, did not prevent a very free amount of movement of the body of the kidney in the arc of a circle, the centre of which was the lower part of the organ. It was no doubt the frequent repetition of this movement (which had been determined in the first place by an abnormal artery of some size that ran to and entered the kidney substance behind and below the level of the hilum) which had caused the sigmoid curve of the ureter and the tough adhesions. This artery had to be severed and ligatured to get the kidney free. In cutting carefully and bit by bit through the condensed fibrous tissue which formed the adhesions, and which distorted the kidney, the ureter was completely divided. The lumen of the ureter was very small, and the walls were very thin. Lateral implantations by Van Hook's method was at once performed. The kidney was afterwards fixed by means of its deflected capsule, and the external wound was closed with a drainage tube left *in situ.*

All went well until the eleventh day, after which the wound became tense and an escape of urine was established in the loin; and on and after the thirteenth day the urine from the bladder which had till then been passed in the same average daily quantity as before the operation, was reduced by nearly one-half.

So matters continued; the wound had to be partly opened up to allow urine to escape, a little suppuration was established, and it was clear that either a fresh union of the ureter must be attempted, or that a permanent fistula must result. I was prepared to make another attempt by re-section and re-anastomosis. The patient, however, refused to have any further operation. At length she consented, when too late to attempt further plastic measures, and nephrectomy was performed on March 17th, 1899. At this time the kidney was found very firmly adherent to the parietes as the result of the nephropexy, but elsewhere all around the kidney there was a considerable urinous space or cavity with thickened, and in places gelatinous-looking walls, smooth and glistening on their surface. The proper capsule of the kidney was thickened and surrounded by a quantity of dense adventitious inflammatory material, and it was found impossible to trace the ureter in this tissue. The kidney was removed, and on examination after removal showed no sign of distension of its pelvis or calyces. The parenchyma was not wasted, but was very friable, though otherwise healthy to the naked eye. The patient made a slow recovery and ultimately got quite well, and so remains to the present time.

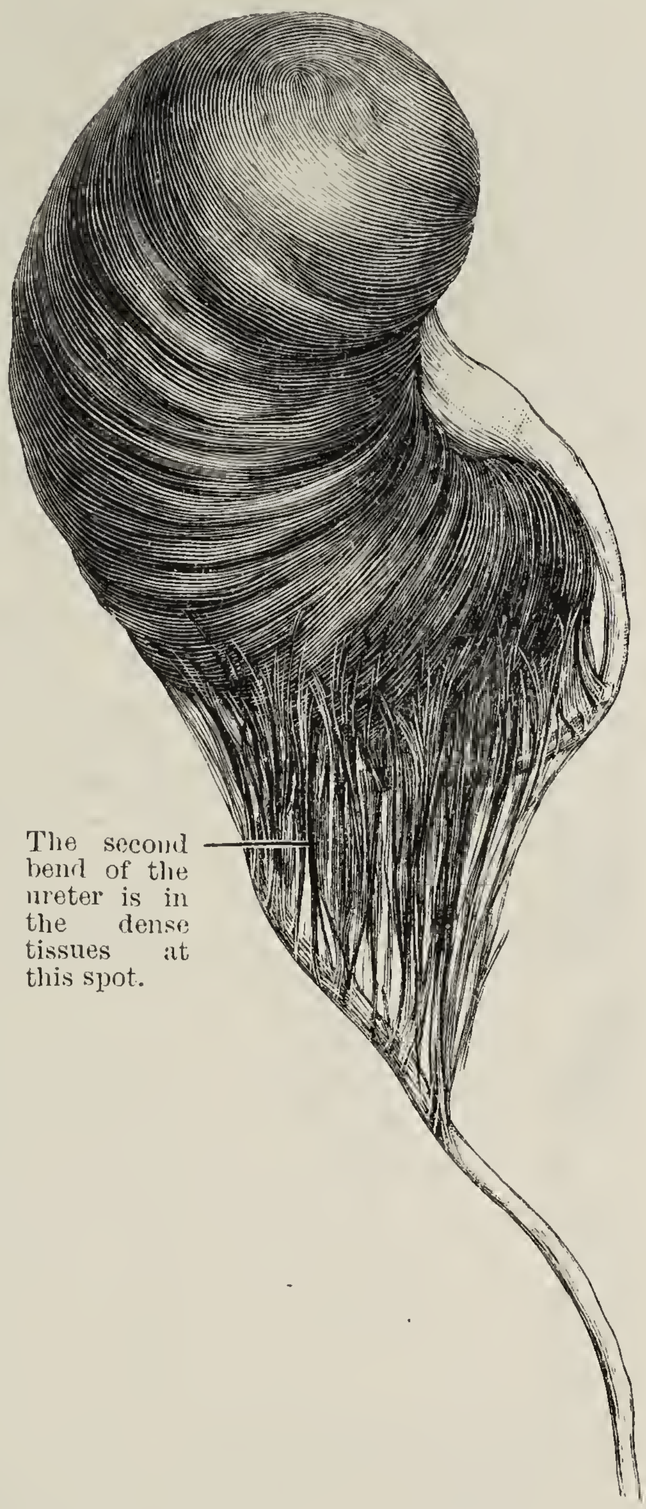
The second bend of the ureter is in the dense tissues at this spot.

Fig. 184.—Diagram of the Right Kidney seen from the front, showing distortion of the Ureter due to bands of adhesions passing from the lower border of the Kidney, and enveloping the Pelvis and Ureter. (Author's case.)

B.—4. *End to end anastomosis by suturing the ends together in an oblique line.*—This was done by Wesley Bovée* on a woman, aged thirty-six, who was being operated upon for a right-sided tubo-ovarian abscess; and in ligating the ovarian vessels near the right side of the pelvic wall the ureter, lying in a dense mass of exudation material, was unintentionally included in the ligature, *and the tissues to the inner side of the ligature, and between it and the abscess, were cut through with scissors.* It was then found that the ureter had been divided, so the lower end was dissected from the abscess wall, and after the removal of the abscess without rupture, together with a large pyosalpinx of the opposite side, the cut ureter was united by end to end anastomosis, by converting the transverse wound into an oblique one with some loss of length of the duct. This seemed necessary, as the lower end had been grasped too tightly by strong forceps, and to the upper end the ligature had been tightly applied, so that both ends were damaged.

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* *Annals of Surgery*, January, 1897, and July to December, 1897.

The operation was performed as follows:—The side of the lower end grasped by the forceps was trimmed off with scissors quite obliquely, and after placing a gauze plaque about the upper portion, the ligature was removed and the ovarian vessels were again ligatured. A very small amount of urine escaped from the cut ureter. The upper portion of the duct was cut off obliquely just above the place that had been constricted by the ligature, and fitted to the lower portion already prepared for the union. The cut ends of the duct were dilated for an inch and approximated with No. 1 silk (such as is used in intestinal work) in the following manner:—"With a small round straight needle a rectangular suture was inserted and tied, not very tightly; two interrupted ones followed, and this process of alternating was continued until the whole circumference of the duct had been sutured; the rectangular sutures were applied as in the liver, or in some other friable tissue. Great care was necessary to preserve an even and exact approximation of the surfaces without puckering, and this was done satisfactorily by the alternation of the two kinds of sutures. Over these sutures were inserted a few, probably four or five, interrupted ones that reached a little further up and down the duct; no suture penetrated the mucous membrane of the ureter. The peritoneum

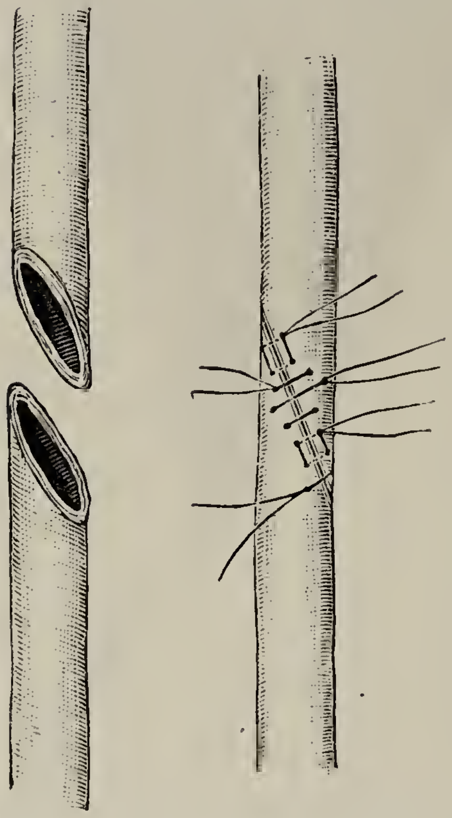
Fig. 185. — Bovée's oblique end to end method of Uretero-ureteral Anastomosis.

was carefully brought over the injured portion of the duct and sutured so as to wall off the ureter from the peritoneal cavity; the toilet was carefully made, and the abdominal wall completely closed with kangaroo tendon sutures in three tiers, all buried: bladder catheterisation was practised every six hours for the two following days." The patient made an uninterrupted recovery, was well in a month, and was discharged from the hospital within a day or two afterwards. When seen four months later both the patient herself and the analysis of the urine gave proof of the satisfactory condition of the kidney of the injured side. The amount of shortening of the duct from resection was, the operator thinks, fully one inch. Fig. 185 explains the method of trimming the ends of the injured ureter, and of applying the sutures, as well as the appearance of the duct after suturing by *oblique end to end anastomosis.*

COMPARISON OF THE MERITS OF THE DIFFERENT METHODS OF URETERAL ANASTOMOSIS FOR TREATING COMPLETE SECTION OF THE URETER.

Van Hook claims that his method possesses these advantages:

1. The urine passes along its normal channel.
2. Healing takes place without a temporary loss of function or a temporary fistula.
3. The ureter can be united with the materials always at hand at any operation during which the injury is likely to happen.
4. No stenosis occurs, even after a long interval of time.
5. Leakage cannot occur, because the upper extremity of the ureter acts as an obstructor to the lower portion of the tube.

He compares it favourably with Poggi's end in end method—

(*a*) Because the invaginated end of the ureter is less likely to be compressed by muscular action of the invaginating portion in the lateral method, since the constricting force cannot act so directly at the immediate point of union.

(*b*) In the lateral method the line of permanent and firm union is not a circle, as in Poggi's method, but an ellipse, so that as the new connective tissue contracts, it cannot result in stenosis.

The first three of Van Hook's arguments in favour of his own method are equally applicable to all the others. The advantages claimed in Nos. 4 and 5 are those upon which the operation must be tested.

His objection to other plans on the ground of stenosis is based on Tuffier's and Büdinger's experiments, and perhaps on Schopf's case; but in Schopf's patient the cautery had been employed to divide the adhesions involving the ureter, and the bad state of health of the patient was unfavourable to good repair.

In any objections made against methods because of the results of experiments on dogs, the small size of the ureters, the effects of chloroform, and the difficulties as to asepsis, ought to be taken into account.

Van Hook's method involves a greater sacrifice of ureter than the others; much more than the transverse end to end method, and even more than the oblique end to end plan of Bovée.

The employment of sutures on the ureter.—Van Hook dissents from the use of sutures in complete transverse injuries of the ureter, except when used in lateral anastomosis; but, as Bovée says, no evil has hitherto been known to arise from them.

The question of sutures is one of doubt and difficulty, and much difference of opinion exists with regard to their employment. As to the deposits of salts upon them, Büdinger says that if a calculus begins to form on sutures in a narrow canal like the ureter, complete obstruction must soon be the result. But the important question is, Does calculus form on these sutures? We have no proof at present that it does, any more than we have of its formation upon sutures used on the kidney.

We have two very different kinds of sutures in Lembert's and Van Hook's.

It is easier to put Lembert sutures into thickened walls without penetrating the mucous membrane than into normal ureteral walls. It is extremely difficult to insert them properly when the walls are very thin. The thicker the cut ends of the ureter, the larger are the apposed cut surfaces to one another in the end to end method, and the easier it is to insert Lembert's sutures.

The fear of concretions forming on the threads in Van Hook's method is probably quite hypothetical, as the sutures are not really in contact with urine. Moreover, calculi are less likely to form at places where urine only "passes over" a surface than in those where it lodges for a time, as it does in the renal pelvis and in the bladder.

Wesley Bovée criticises Van Hook's method thus:—

"The sutures pass through the mucous membrane of the upper end in two places, and between these places are in the lumen of the duct. In our judgment this offers an opportunity for the urine to percolate through the wall of the tube along the sutures"

Van Hook anticipated the objection in regard to the formation of calculi upon the suture material, and to obviate it used catgut, "which will be absorbed in a few days." His method provides also against the percolation of urine.

Respecting the end in end method, Bovée says he cannot endorse it without reserve; the failures of some experimenters lead him to look upon it with suspicion in spite of the successes of Poggi and Mayo Robson. He however looked forward to better results from it. Winslow's success has been published since Bovée's paper.

Of his own method Bovée says:—"Oblique end to end anastomosis is applicable when three inches or less of the ureter have been removed, provided the lowest two inches of the duct are unharmed; if the kidney be movable then it may be depressed to allow anastomosis of the ends of the ureter when a greater extent of the duct has been lost." By this method the objections to all plans other than Van Hook's are, he thinks, obviated. The line of union is much longer than in the transverse union; the ends do not separate, as is their tendency in the invaginated method of Poggi, and the constriction cannot well be of moment. Certainly no suture penetrates the mucosa as in Van Hook's method, a fact which seems to him of no little importance, "especially if permanent suture material be used." But, as mentioned above, Van Hook used catgut, and the proof of the formation of calculus on the sutures is not yet forthcoming.*

Suggestion to shift the kidney to make good a shortened ureter.—Bovée † suggests that when too much of the ureter has been removed to allow either of anastomosis of the ends of the tube or of cysto-ureterostresis being done, the kidney should be freed and stitched to the loin in a lower position so as to allow of one or other of these operations being performed. If the kidney happens to be movable, this can be done easily; if not, the kidney must be made movable by the surgeon. Bovée tried the experiment on a dog, and it succeeded.

The objection as to subsequent stenosis of the ureter occurring has not been urged against Van Hook's operation, and no constriction has been known to follow this method either in the lower animals or in the three women on whom the operation was done by Kelly, Emmet, and Doherty. But Bovée says "a sufficient number of cases of the restoration of the continuity of this duct by the end to end and the end in ends methods have now been reported to prove the fallacy of this objection against them. Nine cases done by these methods have been recorded, three of whom died, but none from urinary complications. Omitting the case of Schopf, which is purely negative, as the patient died of tuberculosis on the forty-second day after operation; of Hochenegg, whose patient died from secondary hæmorrhage twenty days after a sacro-peritoneal hysterectomy for cancer; and of Pawlik, whose patient died from shock fourteen hours after operation, we have six cases to consider. These were done by Tauffer, Robson, Fritsch, Cushing, and the writer. Tauffer being the only surgeon to operate on two cases, experience can have lent no particular advantage to the five operators. Cushing wrote recently that in his case, done five years since, the result is apparently perfect, notwithstanding it is the only one reported in which "leakage of urine occurred after the operation." Bovée's own case, when reported eleven months after the operation, was free from any trouble.

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* In the urinary bladder and in the gall bladder calculi are known to form around sutures; but in the renal parenchyma and in a patent normal ureter, not. In the parenchyma urine is probably not secreted in the track of the suture, in the patent normal ureter it does not remain and becomes stagnant. John Homans has illustrated a case of gall stones around silk sutures in the *Annals of Surgery*, vol. ii., 1897.

† *Ann. Surg.*, September, p. 318.

As far as results go up to the present time, all the methods seem to be on the same footing.

They have all been tested by one or more cases in the human ureter, and the results were reported some months after the operation, and so far no subsequent trouble seems to have arisen, except in Schopf's case, and in my own trial of Van Hook's operation, which ended in extravasation of urine.

Büdinger's and Tuffier's experiments on dogs of the end to end and end in end methods respectively gave deplorable results, probably because the technique was imperfect. Poggi's experiments by the end in end method were absolutely successful. Büdinger,* who repeated Poggi's end in end method, and who discussed Van Hook's, and the subject of the complete transverse injuries of the ureter generally, became discouraged by his results and gave up his experiments.

In an experiment with Van Hook's method the dog was killed twenty-six days after operation. A perfect result without stricture was obtained. "This lack of stricture formation was to be expected from the fact that the line of primary union was an oval, not a circle; the fact that one part of the tube must enter the lumen of the other does not constitute an objection to the method, since the lumen of the tube can be enormously increased by stretching, without prejudice to the integrity of its wall" (Van Hook, March 4th, 1893).

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* *Archiv. für klin. Chir.*, Bd. xlviii., H. 3.

Emmet says this (Van Hook's) is the method to be recommended; it is feasible in every case in which there is no loss of continuity, and probably in those cases where there is some loss. It is immaterial whether silk or catgut is used for sutures; with silk we may fear capillary attraction leading to urinary infiltration beneath the peritoneum, but if we cover the field of operation with peritoneum, plastic exudation quickly established, puts a barrier to that. The knots, he thinks, work their way out of the ureter and remain encysted beneath the peritoneum.

Personally, I consider Van Hook's the method of choice except in cases in which both the cut ends of the ureter are enlarged equally, and then Bovée's plan, would, I think, be equally good, as there would be little difficulty in introducing the sutures, and no fear of subsequent stenosis. Bovée's operation might also be employed where there is rather greater loss of ureter than would allow of the approximation of the ends by the lateral implantation, or anastomosis.

C. RE-SECTION OF A PORTION OF THE URETER FOLLOWED BY URETERAL ANASTOMOSIS.

Re-section of the ureter is the operation whereby an inch or two of the ureter is removed between two complete transverse incisions, followed by suture of the divided ends, and thus the restoration of the ureter as a conduit for the urine. It is a partial ureterectomy which is immediately to be followed by the restoration of the urinary conduit. It was first proposed by M. Marcel Beaudouin in 1891, first performed by Küster in July, 1891, then by Van Hook (1893), by Cramer of Cologne in two cases in 1893–4, by Trendelenburg, Alsberg, and Helferich, and more recently by Bazy and by myself.

Of the above nine operations, all concerned the upper end of the ureter and the renal pelvis, and were therefore cases of partial ureterectomy followed by pyelo-ureterotresis. In all, the operations were undertaken for nephrectasis; in seven for hydro-nephrosis; in two (Van Hook's and Cramer's second case) for pyo-nephrosis, due to some abnormality of the opening from the renal pelvis into the ureter.

When re-section is done for an obstruction situated at the junction of the infundibulum and ureter, anastomosis is easier of performance, and less likely to be followed by cicatricial constriction at the line of operation than when the part excised concerns the ureter lower down, except quite at its lower end, when the cut end of the duct can be grafted into the bladder.

The greater width of the renal pelvis into which the upper end of the ureter is grafted, is the explanation of this.

The results of experiments on animals, and of the cases in which this operation and those of the ureteral anastomosis have been performed in the human subject, have proved that there is no insuperable difficulty in the manipulative details, and there need be no injurious degree of contraction of the cicatrix when the operation is done upon the ureter in any part of its course.

Indication for re-section.—The operation is indicated when a ureteral obstruction of the nature of a diaphragm due to the obliquity with which the ureter joins the renal pelvis, or a dense fibrous stricture, or a tough cicatrix following an ulcer, or stenosis from any other cause is giving rise to retention or partial retention of urine. Re-section of the affected area should be performed, if ureterotomy or simple pyelo-ureterotresis is insufficient to cure the defect, or impossible of performance, in preference to nephrectomy or to the establishment of a urinary fistula.

Pyelo-ureterotresis is capable of removing the obstruction caused by compression of the ureter by an abnormal vessel such as is shown in the Figs. 141 and 142 (p. 297, Vol. II.). Israel has, in one case, thus remedied the compression of the ureter at its orifice by a posterior branch of the renal artery.

In cases of hydro-nephrosis or pyo-nephrosis, whether intermittent or persistent, if the kidney is not hopelessly destroyed, an attempt should first be made to remove the cause of the destruction by ureterotomy or re-section, as the case may be; and if this should fail it will then still be possible subsequently to establish a fistula or to excise the kidney.

As ureterotomy is a simpler operation than re-section, as it causes less disturbance of the connections of the ureter, makes less demand upon the extensibility of its walls, is equally effective in suitable cases, and is attended by fewer risks; it should always be performed, in preference to re-section, for valvular or unilateral or narrow resilient annular strictures, bridle strictures, or scars.

Re-section, being a tedious and delicate procedure, should not be performed unless the patient's general condition is sufficiently good to enable him to withstand the effects of a somewhat prolonged operation.

Re-section is altogether contra-indicated for any patient suffering from advanced renal tuberculosis, extensively diffused suppuration, complete atrophy, or other irremediable condition of kidney, such as pyo-nephrosis or hydro-nephrosis with so advanced a degree of absorption of the renal tissue as to leave little more than a thin shell of secreting substance. In these conditions nephrectomy is the proper resource.

A moderate degree of simple pyelitis is not a contra-indication, especially if the operation is entirely retro-peritoneal. It does not at all follow that the septic urine in such a case will contaminate the wound in the ureter and prevent its healing ; and even should it interfere with the completely perfect primary union of the whole circumference, repair may be perfected after a temporary fistula, by granulation tissue. Even should a trans-peritoneal operation be performed, if the urine is normal, the patient's general state of health good, and the part of the ureter operated upon is well covered over by peritoneum or an omental graft, and drainage is established along an extra-peritoneal route, there will be an excellent prospect of a good result.

The state of the ureter itself however may be a contra-indication. It is only when the whole of the ureteral obstruction can be removed by one re-section that the conditions are favourable for the operation. It is useless to re-sect the upper end of the ureter because of a valve between it and the renal pelvis, and then find that its lumen lower down is completely obliterated, as Van Hook did. Pathological anatomy teaches us that ureteritis is apt to result in a plurality of points of narrowing ; and if there are such in any case in which re-section is contemplated, it is a reason for rejecting the operation. It is well to remember that ureteritis, continuing after the re-section, may subsequently produce stenosis in other parts of the tube, as well as at the part operated upon. A number of strictures or a great length of constricted canal is opposed to re-section.

For its adoption there should be but one stricture, and that should be of no great length. The length of ureter affected should not exceed three and a half inches. It is true that when the ureter is completely divided across, the longitudinal muscular fibres tend to drag the cut ends apart, and this is especially the case in the upper or renal portion of the duct. But, in spite of this, owing to its elasticity and its somewhat tortuous course, traction upon the ureter will increase its length from two to four or even five inches. Still, as the longitudinal muscular coat will exercise a certain degree of pull upon the sutured ends, tending to drag them apart, it would be undesirable to excise more than from two to three and a half inches of the tube. The walls of the ureter are well supplied with arterial blood-vessels, which are not likely to be over-strained by this degree of traction upon them.

The part of the ureter at which the obstruction is situated is another element for consideration. In all the cases hitherto re-sected the obstruction has been near the renal pelvis. Except the difference in the size of the tube there is nothing however to render the re-section of any part of the abdominal portion of the ureter less favourable. In most cases the ureter above the site of obstruction will be dilated, and therefore wider than the part below; but the walls of the lower segment are capable of being stretched in circumference as well as in length; moreover, the union of the parts can be effected by Emmet's modification of Van Hook's plan of lateral implantation (*see* p. 545), instead of by the end to end or end in end method.

If the obstruction is situated near the vesical end of the ureter, and the upper end after re-section can be brought into close contact with the bladder, it would be simpler, easier, and safer to graft the ureter into the bladder than to unite the cut ends.

When the ureter is thickened and dilated the operation is facilitated by the greater ease with which sutures can be inserted, and there is less fear of subsequent contraction. When its walls are thickened and surrounded by tissues which adhere pretty firmly to it, there is also less danger from peristaltic movements and better chance of quick union.

To sum up, ureters most suitable for re-section are those in which the obstruction is single, not multiple, not too extensive in length, of an annular form, and situated either close to the renal pelvis or in the abdominal portion of the tube, or close to the bladder.

When the valve is of the form of a fold or spur rather than a diaphragm; when the stricture is in the form of a unilateral scar, or a narrow, supple, but not tough fibrous ring, ureterotomy, *i.e.* a longitudinal incision through the obstructed wall of the ureter, should be performed instead of re-section.

When the stricture is situated sufficiently near to the bladder, the proximal end of the ureter, after excision of the constricted part, should be grafted into the bladder instead of being united with the distal end.*

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* *See* Israel's case, *post*, p. 570.

When there are multiple strictures, or a great length of the ureter is stenosed, either a ureteral or a renal fistula must be established or nephrectomy performed.

It is unnecessary to describe here the details of the operation of reunion after re-section of the ureter, as to do so would only be to repeat the descriptions already given of pyelo-ureterotresis and ureteral anastomosis. It may be helpful however to add epitomes of the descriptions given of their cases by Küster, Van Hook, and Bazy, so that the reader may obtain a better idea of the clinical conditions for which the operations were performed, and of any modifications in the technique of pyelo-ureterotresis which have been employed.

*Operation for valve and stricture associated in the upper end of the ureter of a single kidney; re-section followed by pyelo-ureterotresis.**

History.—J. H., aged eleven years, was delicate up to his fifth year, then for a good while healthy. For several years his parents noticed that his abdomen was large; from Easter, 1889, the boy complained continually of abdominal pains. On June 23rd he was admitted into the Marburg surgical clinic, where a hydro-nephrosis on the left side was diagnosed. The urine was clear, and was passed in sufficient quantity.

June 28th, 1889. By means of a lumbar incision Herr Braun established a reno-pelvic abdominal fistula. After the operation the patient evacuated 320 cm. on one occasion through the urethra, but after that only a few drops now and then. It was demonstrated beyond doubt that the right kidney was quite wanting, and that the open hydro-nephrosis, as Braun calls this form, had to do with a single kidney. The patient visibly recovered, and was discharged with his fistula. As a postscript to the narrative of this case,† Herr Braun discussed the possibility of searching for the ureter sub-peritoneally, and of bringing it into a fresh and further communication with the kidney pelvis.

May 25th, 1891. The boy, now aged thirteen years, was readmitted into the surgical clinic of Marburg. The fistula had become permanent, the urine being entirely evacuated by this exit. Urine contained some albumen and a few pus cells. Now and again traces of urine were excreted *per urethram*.

June 6th. The fistula was divided, and the sac, now rendered accessible, was examined with the finger; a sinus of large extent was reached at the lower part; investigation by catheterisation failed. The operation had untoward results: pyelitis developed and made the boy's condition very dangerous. By means of prolonged irrigation the state improved, and the patient gained ground again.

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* Küster, "Ein Fall von Re-section der Ureter" (*Archiv f. klin. Chir.*, xliv., 1892, pp. 850–54).

† *Verhandlungen der deutschen Gesellschaft für Chirurgie*, xix., p. 122.

July 14th. It was decided to explore the ureter. Beginning in the lumbar region, and passing downwards and outwards, an incision 12 cm. in length was made through the abdominal wall as far as the peritoneum; the latter was detached with blunt instruments and drawn towards the median line. The ureter however could not be found without something further being done. Küster therefore divided the convex portion of the hydro-nephrotic kidney in its lower area, at the upper border of which a layer of kidney substance the thickness of a thumb was visible. He now found the ureter, which extended several centimetres upwards in the posterior wall of the sac, ending with a slit-shaped aperture. Into this aperture Küster introduced a probe-pointed knife and divided the canal to near its exit from the sac, with the intention of establishing, by means of wing-shaped continuations of the canal-wall and superficial suturing of the same to the sac-wall, a funnel-shaped opening of the ureter (*see* Fig. 166, p. 438, Vol. II.). When however, a fine probe was introduced into the canal so as to find out the course the ureter took, the instrument, to the operator's intense and unpleasant surprise, encountered some 2 cm. below the sac a perfectly impermeable stricture which from without appeared nodose. This, when the ureter was divided from top to bottom as far as the stricture, was traversed with a fine probe. It did not appear possible to remedy the condition unless the stricture was thoroughly removed. Consequently the ureter was cut through close below the stricture, and for the second time, at its junction with the kidney-sac, and the intervening segment was removed. The cut end of the ureter was then loosened so far that it fitted comfortably into the kidney-sac and its orifice was split in the anterior median line for some 1½ cm. downwards (Fig. 166, p. 438, Vol. II.), the edges stretched apart, and the posterior wall of the ureter superficially sutured to the previously freshened wall of the kidney-sac, so that a funnel-shaped aperture for convenient reception of the urine was formed (Fig. 166, p. 438, Vol. II.). Then the incision, also through the lower expansion of the kidney-sac on both sides of the ureter, was united to the latter again by means of catgut sutures. The wound cavity was plugged with aseptic dressing, the wound at the upper angle sutured, and the ends of the plug were brought out to the lower angle of the wound.

The next day a slight quantity of blood-stained urine was evacuated *per urethram*, and similar evacuations continued, although by far the greater proportion of urine escaped through the lumbar fistula. Quite four months after the operation, appears a record for the first time that the evacuations of urine had latterly increased, that urine was passed four to five times daily, and amounted to some 100 cm. in twenty-four hours. The urine continued very turbid and strongly albuminous. Systematic washing out of the pelvis of the kidney with a quarter per cent. solution of nitrate of silver was therefore undertaken, which resulted not only in rendering the urine free from pus, but also in reducing the albuminous contents to almost vanishing point so that there was but slight turbidity. The patient's general condition thenceforth improved extraordinarily; the lad gained flesh visibly. An attempt at probing the ureter again failed, even now. The lumbar fistula continued with the canal-wall quite healed over.

An attempt at operative closure of the fistula was made on the 6th of November, by extensively freshening the canal as far as into the kidney tissue, and uniting its walls by rows of sutures. After five hours blood-stained urine escaped through the urethra. Altogether within the first twenty-four hours 1,300 cm. were secreted; the urine, at first strongly blood-stained, afterwards became clearer. Meanwhile the attempt succeeded perfectly, and the fistula closed. The urine was generally excreted at an interval of an hour and a half, and mostly reached the normal quantity; it still contained some amount of pus and albumen.

December 4th. The boy was sent home in an excellent state of health. When seen again later his general condition was very satisfactory; appetite and digestion were normal; and he was free from all discomfort. The urine was strongly acid, slightly turbid, contained when filtered a fair amount of albumen and, microscopically, a large number of pus cells. At the point of the operation cicatrix a hernia had developed, which necessitated the boy wearing a firm truss; with this he was in a condition to work.

The value of this case, as Küster remarked, consists in pointing out a way by which in a case of hydro-nephrosis, especially when the second kidney is undoubtedly unsound, damaging and dangerous nephrectomy may be avoided. Küster presented the case as a warning that we must be more conservative in our renal surgery.

In hydro-nephrosis, nephrectomy must frequently give place to nephrotomy, and in nephrectasis when due to valve or stricture of the ureter it must yield to ureterotomy, pyelo-ureterotresis, or uretero-ureteral grafting. In the subsequent discussion on Küster's case, Trendelenburg stated that he had operated on a similar case, but that the operation was followed by illness and death Alsberg of Hamburg also observed that he had had a similar case.*

A case of re-section† *of the upper end of the ureter for valve. Pyelo-ureterotresis, followed by nephrectomy, because of complete obliteration of the ureter lower down.* Van Hook described his operation thus :—

"A boy aged thirteen suffered from an attack of typhoid fever. Following this attack, some weeks later, he developed a pyo-nephrosis. We established a fistula upon the abdominal wall, the sac discharging a large amount of urine. As the fistula remained permanent I operated, upon the invitation of Dr. Halstead, for the purpose of restoring the normal channel for the discharge of the urine.

"The incision was practically that used by Küster and others, beginning at a point two inches to the left of the posterior median line, carried down for an inch and a half almost straight, and then curved forward towards the anterior superior iliac spine. As soon as the anterior lumbar fascia was opened the ureter was discovered without difficulty. It was smaller than normal, and seemed to be atrophied. The kidney dilated on account of partial closure of the abdominal fistula, could easily be felt in its normal position. Upon opening the renal sac and allowing part of the fluid to escape, the finger could be easily passed into the pelvis of the kidney, but no stone was felt. I then made a ureterotomy, and passed a probe up the ureter to meet the finger; but between the finger and the probe I could distinctly feel a valvular fold of mucous membrane. Concluding that this was the obstruction which had prevented the normal discharge of urine, I proceeded to resect after Küster's method, and succeeded in implanting the ureter into the sac, much as he had done. It was now thought best to explore the ureter in the direction of the bladder. Upon passing a probe downward a short distance the ureter was found to be entirely obliterated for several inches. There was nothing left to do but to extirpate the kidney. The patient recovered."

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* *Verhandl. der deutsch. Gesellsch. für Chir. Kongress*, 1892.

† Weller van Hook, *Journ. Amer. Med. Assoc.*, December 16th, 1893.

Pyelo-ureterotresis after re-section of 4 cm. of the ureter for hydro-nephrosis due to oblique connection of ureter with renal pelvis.—M. Bazy* performed, in October 1896, an operation similar to Küster's, and to which he gave the name of "Urétéro-pyélo-néostomie."

His patient was a man aged forty with a large hydro-nephrosis, for which relief was given by evacuating the pent-up urine by laparotomy. This gave M. Bazy the opportunity of ascertaining that the hydro-nephrotic kidney was of very fair secreting capacity. The cause of distension was the abnormality of the connection of the ureter with the renal pelvis; it opened into the infundibulum above its equator instead of at its lowest part. An incision into the hydro-nephrotic pouch was prolonged downwards and backwards; 4 cm. of the ureter were cut away; the cut end of the ureter was split longitudinally to the extent of a centimetre and a half so as to enlarge the orifice of communication, and was then fixed to the back of the dilated infundibulum at its most dependent part. On the seventh day after the operation the urine was passed from the kidney operated upon into the bladder. One month later the abdominal wound was completely healed. At the end of five months the patient reported himself as being in excellent health.

Author's case of pyelo-ureterotresis after re-section of three-quarters of an inch of the ureter; the kidney, was movable, with an oblique valvular connection of the ureter with the renal pelvis.—In 1897 I operated upon a female aged fifty-seven for painful movable kidney with intermittent hydro-nephrosis, and found the ureter running obliquely in the wall of the distended renal pelvis.

After exploring the kidney through an incision in its convex border, I first laid the ureter and renal pelvis freely open into one another by a longitudinal incision, and stitched the divided edges of the ureter to those of the renal pelvis. The result was not satisfactory, so I excised three-quarters of an inch of the ureter, closed the greater part of the incision in the renal pelvis, and then sutured the ureter to the lowest part of the infundibulum.

Again the result did not satisfy me because of the small calibre and extreme tenuity of the ureter; so, to avoid a fistula and a long convalescence on the one hand, or stenosis of the ureter at the site of operation and a subsequent nephrectomy on the other hand, I removed the kidney there and then. The patient made an excellent recovery. Had she been younger and more robust I should, even with so small a ureter, have given the plastic operation a chance of succeeding. The case however testifies to the feasibility of Küster's operation when the ureter below the constriction or valve is of even less than normal calibre and thickness.

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* *Acad. de Méd.*, May 30, 1897.

The illustrations on pages 534–5 (Vol. II.) show an incision in the convex border of the kidney, with a bougie passed through it into the hydro-nephrotic sac. As the bougie could not be made to enter the ureter through this incision, a small buttonhole was made in the sac, and through this the bougie entered the ureter, and upon it an incision was made into the ureter at the angle between it and the sac. Both sac and ureter were then divided longitudinally with scissors, and the ureterotomy was partially completed by two sutures, one on each side of the section of the ureter and sac. It was then thought the result would not be satisfactory, and so re-section was made of the ureter from the opening into the renal pelvis for three-quarters of an inch downwards. The cut end of the ureter was sutured to the lowermost part of the sac, and the rest of the opening into the sac was closed by several Lembert sutures. The reason in this case for incising the kidney along its convex border was to explore for calculus, as the lady had passed a little grit and had been said to be suffering from renal calculus by a surgeon who catheterised the ureter. No stone was present.

I have had a very similar experience since, in a case of Mr. Rayley Owen's. The lady had long been suffering from attacks of renal pain, which became at length more and more frequent. I diagnosed the cause to be a constriction of the upper end of the ureter at its junction with the renal infundibulum, and this it proved to be. At the time of the operation the renal pelvis was distended to the size of a large orange, the calyces were deeply pouched, the parenchyma atrophied, and the ureter small in calibre and with extremely thin and delicate walls. Pyelo-ureterotresis was tried, first without, then after re-section of the upper end of the duct, but it not proving satisfactory, as I thought, the kidney was there and then removed.

CHAPTER XVI.

PLASTIC OPERATIONS ON THE URETER
(*Continued*).

URETERAL GRAFTING (URETERO-ETEROPLASTY).

WHEN the ureter has been injured, and the injury is attended with a loss of substance so considerable as to make reunion of the ends impossible, some operative procedure other than uretero-ureteral anastomosis is required. The simple ligation of the two ends of the ureter and nephrectomy were the only alternatives until ureteral surgery with antiseptic precautions had made a definite start, first by experiments on animals, then by the careful and tentative application of some of the methods to man.

At the present time some form of ureteral anastomosis or grafting should when possible be practised; nephrectomy and the application of a ligature to the divided ureter of a healthy kidney ought to be abandoned, except in cases in which anastomosis or grafting are impossible.

An immense amount of labour and ingenuity has been directed to devising methods (1) for the cure of ureteral fistula; (2) for preventing either ureteral fistula or nephrectomy in cases in which there has been a loss of substance too great to permit of uretero-ureteral anastomosis.

Very numerous for instance have been the experiments to test the feasibility of grafting the cut end of the ureter (1) into the bladder, (2) into the rectum, (3) into other parts of the small and large intestines, (4) on to the cutaneous surface, and (5) into the other ureter.

Various other ingenious plans have been proposed as substitutes for nephrectomy, whereby the urine is conducted to the bladder even after parts of the ureter, too great to permit of uretero-ureteral anastomosis, or of bladder grafting, have been cut away or otherwise destroyed. But the results of actual operations upon man show that grafting into the bladder—cysto-ureterotresis or uretero-cysto-neostomy, as Bazy has named it—ought to be the operation of choice when it can possibly be done, for injuries and fistulæ involving the lower end of the ureter.

GRAFTING THE URETER INTO THE BLADDER.

History of the operation.—Poggi,* in 1887, seems to have been the first to conceive the idea of transplanting the ureter into the bladder at an abnormal situation, and to make experiments for this end. Novaro, and eight months after him Bazy, were the first to perform uretero-cysto-neostomy.

Paoli and Busachi by their experiments on dogs, published in 1888,† proved the feasibility and success of vesical grafting. They split the upper end of the segment of the ureter, and united it by sutures to the edges of an incision in the bladder.

In the same year Racidmousky and Tizzoni tried the same experiments, which, however, were always in their hands followed by stricture of the ureter at the level of the new orifice. Hegar and Schede also experimented with fair success in implanting the ureter into the bladder to cure congenital ureteral fistulæ. The principles established by these experiments on animals were applied to surgery by Baumm in 1892, by Novaro in 1893, by Penrose in the early part of 1894, by Krug in the latter part of the same year, and by several other surgeons since. Lannelongue of Bordeaux, in 1895, fixed the ureter at a buttonhole in the posterior vesical wall and passed a catheter into the ureter, bringing out its other end through the urethra.

Davenport of Boston, in 1898, for abnormal ureteral opening; Baumm, in 1892, for supernumerary and abnormal ureteral orifice; and Novaro and then Bazy, each in 1893, with the object of curing uretero-vaginal fistulæ, grafted the ureter into the bladder by methods to be described later on. Since that date (1893) uretero-vesical grafting has been successfully performed by many surgeons. Boari ‡ has devised a button for grafting the ureter into the bladder. With this button of Boari, Chiaventone, and several other surgeons have operated with success. §

Indications for cysto-ureterotresis or uretero-cysto-neostomy.—Cysto-ureterotresis is indicated as an immediate operation for division or loss of substance of the ureter caused by accidents during abdominal or pelvic operations; it has also been resorted to as a means of curing (1) ureteral fistulæ involving the lower end of the ureter; (2) congenital abnormal openings of the ureter into the vagina, prostate, or urethra, or on the external surface; (3) ureteral stenosis and stricture involving the lower end of the ureter; (4) after re-section of part of the bladder for vesical tumour involving the ureteral orifice; (5) in certain cases of calculus impacted at or near the lower end of the ureter, attended with perforation, stenosis, or much destruction of the ureteral wall; (6) it has also been adopted in certain cases of cancer of the uterus involving the ureter, but the utility of it in such cases is very doubtful. In some hysterectomies for uterine cancer it has been found that the whole of the disease could not be removed without taking away a piece of the ureter.

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* *Riforma Medica*, 1887, p. 53.

† *Ann. des Maladies des Organ. génito-urinaires*, 1888.

‡ *Ann. des Maladies des Organ. génito-urinaires*, 1896.

§ *Ann. des Maladies des Organ. génito-urinaires*, 1900.

There are three chief methods of performing cysto-ureterotresis as a primary operation, *i.e.* at the time of the injury to the ureter: (1) the intra-peritoneal; (2) the trans-abdominal but extra-peritoneal; and (3) the vaginal. When the operation is secondary, *i.e.* done some time after the injury, when a uretero-uterine or uretero-vaginal fistula is established, there is a fourth method of procedure which is capable of many variations in details, viz. the invagination or displacement of the fistulous aperture into the bladder, through an opening in the vesico-vaginal septum.

The different forms of vesical implantation of the ureter may, therefore, be classified as follows:—

A. Grafting the ureter into the bladder by an extra-peritoneal route through an incision in the abdominal wall.

B. Grafting the ureter into the bladder by an intra-peritoneal operation.

C. Grafting the ureter to the bladder through the vagina.

(*a*) Invaginating the *fistulous aperture* itself into the bladder after first incising the vesico-vaginal septum.

(*b*) Obliterating the fistulous aperture and establishing a new communication between the ureter and bladder.

The supra-pubic trans-vesical method of Baumm and Bazy is an extra-peritoneal operation in which the abdominal incision is the ordinary one for supra-pubic cystotomy. It is not a method to be followed.

Thus the methods of grafting may be divided into two chief classes, viz. the vaginal and abdominal; and the abdominal again into those which are entirely intra-peritoneal (Krause's, Kelly's, Boldt's, Penrose's, and Krug's), and those which, though trans-peritoneal for the purpose of freeing the end of the ureter, are in reality extra-peritoneal in their technique of grafting the end of the ureter into the bladder (Witzel's, Bazy's, and Veit's).

These methods, delicate and difficult though they be, have given several very excellent results.

When the vaginal route is practicable it is to be preferred, as it avoids any possible risk to the peritoneum from the urine, if the kidney or bladder happens to be in a condition of infection; but if the vaginal route is impossible, or has been tried and proved unsuccessful, the course to adopt is one of the abdominal procedures, and preferably Witzel's or Bazy's trans-abdominal extra-peritoneal operation. It is true that, to succeed by these methods and to escape the dangerous consequences of intra-peritoneal extravasation of urine, perfect immediate union is requisite, so that Poggi is of opinion that if the vaginal methods fail, one of the indirect methods of curing the fistula, viz. kolpo-kleisis or nephrectomy, ought to be selected. But, on the other hand, the admirable results obtained by the intra-peritoneal method of uretero-vesical implantation by Tuffier, Penrose, Krug, Kelly, Busch, Baldy, and Boldt; and by the extra-peritoneal method by Novaro, Bazy, Witzel, Veit, and Israel, give much support to the proposal of Paoli and Busachi to apply this operation to all uretero-uterine and uretero vaginal fistulæ. In congenital uretero-urethral fistula in the male, I should certainly be inclined to give the preference to the abdominal rather than to a perineal or trans-vesical route. Fenger, also, referring to Penrose's and Krug's cases, says, "If the operation is as safe and certain as the above cases indicate, and if the future function of the implanted ureter remains undisturbed, this method" (intra-peritoneal) "would seem to be superior to the other plastic operations."

The following is a brief description of each of the plastic operations which have been practised or proposed. In the performance of any of them the greatest care should be taken against stricture or stenosis of the newly made ureteral orifice.

It may be found in attempting any of these abdominal operations that intestinal and other adhesions in the pelvis prevent the ureter from being reached.

Changes in the appearance of the ureter may cause difficulty in recognising it. As a means of bringing the ureter into more or less relief, Tuffier advises the introduction of a finger of an assistant into the vagina, and pulling on the ureter.

A.—THE EXTRA-PERITONEAL ABDOMINAL METHODS.

1. **Trans-abdominal extra-peritoneal method.** — The trans-abdominal extra-peritoneal method was resorted to with success almost simultaneously by Novaro and Bazy, the latter of whom gave his operation the name of "Urétéro-cysto-néostomie." It has the advantage of leaving the ureter outside the peritoneum, and therefore of sheltering it from the risk of intestinal adhesions. Witzel's method, to be afterwards described, is specially planned with this view. In this respect the operations performed by these surgeons are superior to the intra-peritoneal operations, as well as to that of Veit * in which the ureter, though sutured to the bladder outside the peritoneum, remains free in the peritoneal cavity for a certain distance near the bladder.

NOVARO'S OPERATION.† — The operation was done in 1892, on account of a uretero-vaginal fistula following vaginal hysterectomy, which had been performed two months previously.

The patient was placed in the Trendelenburg position; an incision 5 to 6 inches long, starting from the symphysis pubis, was made in the median line of the abdomen.

The intestines were kept out of the way by means of a flat sponge, and the abdominal walls were well retracted. The ureter was traced and its lower end dissected out from the vagina, split up for a distance of 1 cm., and its extremity unfolded before being thus united by sutures to the bladder. A male catheter or sound was then introduced through the urethra and made to project the bladder in the neighbourhood of the ureteral orifice. The bladder wall was cut through two fingers' breadth above the normal ureteral opening, for the length of 1½ cm., and the end of the ureter was attached to the opening in the bladder by several sutures, which included the whole thickness of the ureteral and vesical walls.

With the view of securing an extra-peritoneal escape of urine in case of failure of the sutures and of immediate union of the wound, Novaro closed the wound in the pelvic peritoneum, made for the purpose of reaching the ureter, and then detached the peritoneum from the pubis to the position of the sutures uniting the ureter and bladder, and along this tract introduced a drain of sterilised gauze, which assured the extra-peritoneal escape of the urine, if any filtered through along the line of the graft.

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* *Zeit. f. Geb. u. Gyn.*, 1894, Bd. xxxi., p. 454.

† *Bull. de la Soc. Acad. de Bologne*, Sept, 1893.

Bazy's Operation.—Bazy,* after two unsuccessful attempts with trans-vesical grafting by the hypogastric route without opening the peritoneum, at length resorted to the trans-abdominal route as Novaro had done. His opinion was ultimately that the trans-abdominal method gives more certainty and rapidity of operating, and causes the minimum amount of injury to the tissue. He changed his opinion in favour of the trans-peritoneal route because of the difficulty, even with the aid of catheterisation and the cystoscope, in making out the distance between the fistula and the vesical orifice of the ureter. His plan differed, however, from Novaro's in this respect: (1) Before suturing the ureter to the bladder, he introduced a red rubber catheter (No. 14) into the ureter, and then directed it through the wound; (2) he closed the peritoneum over the ureter by a whip-stitch of catgut suture, and employed Mikulicz tampon over the seat of the operation, but not along an extra peritoneal tract made for the purpose.

Pozzi has reported a successful case by much the same method.† Bazy claims Pozzi's operation as like his. Pozzi says it was like Novaro's. Rontier describes a successful case of abdominal uretero-vesical grafting, done after the method of Bazy, for a uretero-vaginal fistula consecutive to a confinement.‡

Rouffart's Method.—Rouffart of Brussels has succeeded by an abdominal method of his own. He made his incision along the outer border of the right rectus muscle, and effected the operation by a para-peritoneal route.

Witzel's Operation.§—Through a median abdominal section a small incision was made through the peritoneum over the iliac vessels, and the thickened ureter isolated. Slight traction on the ureter at this spot enabled it to be exposed through another small incision in the broad ligament; here it was doubly ligatured and divided between the ligatures. The distal end after sewing over the stump was buried. The proximal end was brought out by traction at the peritoneal incision over the iliac vessels. With a pair of long forceps guided behind the peritoneum to the right of the vesical region "above the linea innominata," the ureter was drawn down again to the bladder.

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* *Ann. des Maladies des Organes génito-urinaires*, 1894, p. 481.

† *Ibid.*, 1895, p. 428.

‡ *Bull. et Mém. de la Soc. de Chir.*, t. xxi., p. 811.

§ *Centralblatt für Gynäkologie*, 1896, No. 11, p. 289.

The two small incisions of the peritoneum in the pelvis, and that in the antero-parietal peritoneum, were now closed, so that the remaining part of the operation was done extra-peritoneally. The bladder, containing a moderate quantity of boric acid solution, was with gentle traction brought above the middle of the iliac fossa, so that the end of the ureter could be easily placed, for a distance of 4 cm. upon the upper convexity. With some strong catgut sutures the bladder was fastened in this position.

Opposite the obliquely cut end of the ureter a small opening was made into the bladder over a catheter which had been introduced through the urethra. A circular set of interrupted fine catgut sutures was used to unite the ureteral and vesical mucosa; and an additional set of similar sutures fixed the other coats of the walls of the ureter and bladder. A fold of the bladder, parallel to the ureter and on either side of it, was made, and the lips of these folds were united with each other so as to form an oblique canal 4 cm. in length. A glass drain communicated with the point of implantation through a separate opening in the abdominal wall, and the median abdominal incision was closed in the usual way. A catheter was retained in the bladder for four days. Recovery was uninterrupted.

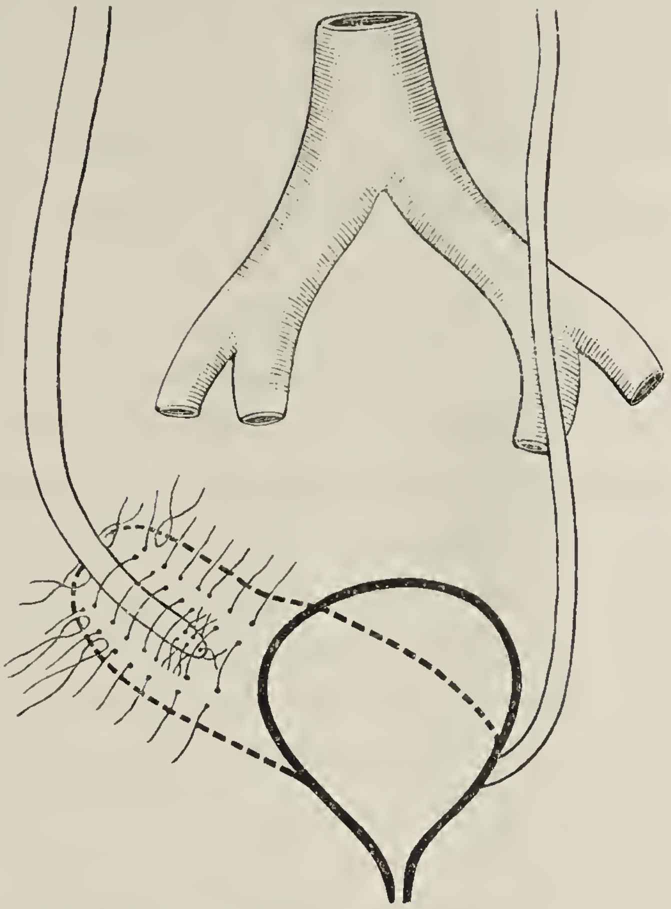

Fig. 186.—Implantation of Ureter into the Bladder: Witzel's Method. The black lines indicate the bladder. The dotted lines show the bladder pulled into its new position with the ureter sutured to it.

It was to avoid the traction of the bladder upon the uretero-vesical graft that Witzel sutured the bladder with coarse catgut sutures to the pelvic wall, as near as possible to the ureter, and for greater security fixed the ureter, after introducing it into the bladder, by two layers of catgut sutures, the deep layer uniting only the mucous membranes of ureter and bladder, and the superficial layer the muscular and cellular tissue coats.

Veit's Operation.—In the following operation the ureter was made to take a course across the peritoneal cavity, but was sutured to the bladder outside the peritoneum.

J. Veit* made the grafting by a trans-abdominal extra-peritoneal method. In the course of removing the diseased uterine appendages he injured the ureter laterally. He brought the lower part of the upper portion of the ureter out of the abdominal wound, and fixed it with two sutures to the tissue outside the peritoneum. Then he carried the parietal incision down to the symphysis, and opened the bladder extra-peritoneally on its anterior surface. The ureter was cut obliquely, so as to enlarge its cut surfaces, and was sewn into the bladder. The recovery, it is stated, was satisfactory.

Veit's method, though in a sense extra-peritoneal so far as the actual grafting is concerned, yet by taking the lower portion of the ureter across the peritoneal cavity of the pelvis, has most of the disadvantages of intra-peritoneal implantation. These disadvantages are the possibility of intestinal adhesions forming around the ureter and dragging upon or compressing it; and the pressure upon and distortion of the ureter, with corresponding impairment of the functions of the kidney in the event of pregnancy subsequently occurring.

By Witzel's method, and to a great extent by Novaro's and Bazy's operations, these dangers are averted.

2. **Extra-peritoneal cysto-ureterotresis through the lumbo-ilioinguinal.**—Büdinger has proposed to perform the operation by a method entirely extra-peritoneal, using for this purpose the lumbo-ilio-inguinal incision which Israel and I and others employ for examining or removing the ureter from end to end. This incision is not so convenient in the female (for whom the operations of uretero-vesical grafting are most likely to be required) as in the male, owing to the difficulty presented by the broad ligament to the extra-peritoneal exposure of the lower or pelvic portion of the ureter.

J. Israel reports † the following case of vesical grafting entirely extra-peritoneally :—

In a girl of twenty the illness began with frequent and extraordinarily painful micturition. After previous ineffective treatment she was much wasted, weighing 44 kilos. (88 lbs.) only, and passing a moderate amount of turbid urine without tubercle bacilli. Vaginal palpation of the bladder trigone was very painful, the viscus having an unusually small capacity.

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* *Zeitschrift für Geburtshülfe und Gynäkologie*, xxxi., 462.

† *Berl. klin. Wochensch.*, 27th February, 1899, p. 201 ; and *Freie Vereinigung der Chirurgen*, February 6th, 1899.

Gradually febrile disturbance subsided, then the tenderness, and later the enlargement of the kidney, which marked the duration of a paroxysm. Afterwards the capacity of the bladder, through systematic treatment, became sufficient for a cystoscopic examination. This showed that the bladder was healthy —on the left side purulent, on the right clear urine was entering it. The notes of the subsequent course of the case run as follows: February 18th, 1898. Left kidney mobile, elastic and fluctuating; kidney pelvis the size of a hen's egg; the ureter an elastic full tube. Nephrotomy and drainage of kidney were adopted; 3 cm. above the vesical orifice was discovered, by means of retrograde ureteral catheterisation, an absolute obstruction. Further soundings were made without success. Healing of nephrotomy wound except for a fistula complete. October 14th, 1898. Resection of the strictured spot and implantation of the upper part of the divided ureter into a new opening in the bladder through the lumbo-ilio-inguinal extra-peritoneal incision. In order to obviate stenosis of the new ureteral orifice, 1 cm. of the ureter was slit open and exact union of ureter and bladder mucous membrane secured. After temporary closure of the kidney fistula, showing that the ureter was completely pervious, on November 16th, 1898, the fistula was permanently closed. Healing of this wound was obtained and with it complete *restitutio ad integrum.*

The cause of the stricture was not cleared up.

3. **Trans-vesical cysto-ureterotresis.**—*The trans-vesical method of Bazy.*—Bazy, in two operations for the cure of uretero-vaginal fistula, sought the part of the ureter in immediate contact with the bladder by the hypogastric route through the bladder. He introduced a director into the ureter from the bladder, incised the bladder on this director as far as the point where the vesical end was obliterated, continued the incision of the bladder until he reached the ureter above the cicatricial tissue, and then incised the ureter for the extent of 1 cm. and sutured the lips of the ureteral to those of the vesical incision, after re-secting the fistulous orifice.

But this plan is only feasible for cases in which the obstruction or fistula is situated at or in the immediate vicinity of the bladder, and has been condemned by its designer in favour of the trans-abdominal extra-peritoneal method, which he afterwards employed as described above. It is inferior to both the vaginal and the trans-peritoneal operations and is not a method to be recommended, except in cases of vesical tumour, and even then the plan of Amour is better (*see* below).

In a patient with a double ureter on the right side, one of which ended at the mouth of the urethra, Baumm* performed, in 1892, supra-pubic cystotomy, and then cut an opening through the bottom of the bladder and connected this opening in the vesical wall with the proximal end of the supernumerary ureter, the distal end of which was ligatured.

Baumm chose this operation because the patient was a virgin, but he does not recommend it, thinking it unnecessarily severe. He considers the operation through the vagina preferable.

Albarran also employed the supra-pubic trans-vesical method for incontinence due to a supernumerary ureter opening into the vagina of a girl aged twenty, but in this case the operation was unsuccessful owing to the giving way of the sutures.

Albarran in 1892 suggested the same operation for the excision of tumours of the bladder involving the end of one ureter, and it has been employed in at least two such cases. Thus Vincini by means of supra-pubic cystotomy removed from a man aged forty a papillary carcinoma of the bladder occupying the area of the ureteral orifice. The tumour was cut out by means of an elliptical incision, the greater part of the wound was closed by sutures, the ureter was drawn in at the angle of the incision, and its mucous membrane was sutured to the mucous membrane of the bladder. Recovery followed.

Küster in 1896 operated upon a man aged thirty-two for growth in the bladder, by means of a supra-pubic cystotomy, followed by the excision of a large portion of the bladder-wall and several centimetres of the ureter. The ureter was sutured in the upper angle of the gap in the bladder (left by the excision of the growth), which was then closed by sutures. The patient recovered.

A very similar operation was performed by Amour of Bologna † for vesical new growth. Amour, in operating for a tumour of the bladder by supra-pubic cystotomy in 1898, met with a growth at the left ureteral orifice and the lower end of the left ureter. After stripping the peritoneum off the back of the bladder he removed the growth with part of the bladder and the lower part of the ureter, closed the vesical wound, and grafted the cut end of the ureter into the bladder at a point higher up than the wound.

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* *Centralblatt f. Gyn.*, 1892, No. 17, p. 336.

† A. Boari's paper in *Ann. des Mal. des Org. génito-urinaires*, 1899.

4. **Sub-pubic method: the procedure of Colzi.***—Colzi operated upon a young girl who was the subject of incontinence of urine due to the left ureter opening abnormally into the inferior part of the vagina, near to the vestibule. On the right of the ureteral orifice was made an incision representing two arcs of a circle united at the upper angle, the summit of the arc corresponding to the pelvis and the branches to the genito-crural folds, and a second oblique incision was made from the first incision, then the soft parts were divided and separated from the pubis, and the pre-vesical space was entered by crowding down the urethra and vagina; then the bladder was cleared on the left side so as to reach the part where the ureter normally enters. A sound was now passed into the ureter as a guide, and the ureter, after being separated from the vagina, was cut across transversely; next, guided by a sound introduced into the urethra, an incision two centimetres long was made through the bladder wall in such a manner that whilst the muscular coats were divided in the whole length of the incision, the mucous membrane was divided to the extent of one centimetre only. The mucous membrane of the bladder was sutured to that of the ureter, and to strengthen the union the bladder wall was stitched over the ureter by Lembert's sutures.

The upper end of the inferior segment of the ureter, which opened on to the vagina, was simply closed, and its epithelium was destroyed by injecting chloride of zinc. The wound was drained with iodoform gauze and cicatrisation was complete in fifteen days.

B.—THE INTRA-PERITONEAL METHOD OF CYSTO-URETEROTRESIS.

By intra-peritoneal methods the ureter is more or less dissected up from its bed and drawn across the peritoneal cavity of the pelvis to reach the bladder. When there has been much loss of length of the ureter this plan may be unavoidable if the duct is to be grafted at all into the bladder. But the same objections apply to it as have been mentioned in connection with Veit's method. There are, however, at least four cases of intra-peritoneal cysto-ureterotresis for uretero-vaginal fistula on record, all of which were successful. In each of these operations there were differences in the technical details.

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* *Lo Sperimentale*, 1895.

KRAUSE'S METHOD.—Krause,* whilst doing a vaginal hysterectomy in 1894, purposely established a ureter-vaginal fistula. Subsequently it resisted attempts at closure *per vaginam*, whereupon he cured it by the following mode: he opened the abdomen and liberated the lower 5 cm. of the ureter, and slit its wall so as to enlarge the orifice of the ureter; into the anterior and into the posterior wall of the ureter, 1½ cm. above the cut surface, a long silk suture was inserted, then a long pair of dressing forceps was passed into the bladder by way of the urethra, upon which the bladder was opened and the silk threads were caught and brought out at the external urethral orifice. The ureter was then sewn to the bladder with four interrupted sutures and the abdomen closed. The patient recovered.

KELLY'S METHOD.—In 1894, at about the same date as Krause operated on his patient, Kelly † in a case of uretero-vaginal fistula, the result of vaginal hysterectomy, opened the abdomen and detached the ureter; but finding it was not long enough to allow of a successful grafting, devised a plan to make up for loss of part of the ureter in order to allow of its reaching the bladder without strain. Instead of suturing the bladder against the iliac fossa as a holdfast, as Witzel had done, he detached the bladder from the horizontal rami of the pubes and then was able to implant the ureter into the bladder without strain on the ureter. In order to enlarge the ureteral orifice he slit the ureter along its under aspect about 4 mm., as Krause and others had done.

BOLDT'S METHOD.—Dr. H. J. Boldt, in an excellent paper on "Implantation of the Ureter into the Bladder by Abdominal Section for the Cure of Uretero-vaginal Fistula," ‡ describes the method he adopted for the cure of a case of uretero-vaginal fistula four months after the ureter had been wounded during vaginal hysterectomy. "A gum elastic catheter was passed into the ureter from the vaginal opening to act as a guide for the abdominal work. The

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* *Centralblatt f. Chirurgie*, 1895, No. 9.

† *Johns Hopkins Bulletin*, February, 1895.

‡ *Amer. Journ. of Obstetrics*, 1896, vol. xxxiii., p. 850.

abdomen was opened and the patient placed in pelvic elevation. In the lower segment the ureter was not mobile, owing to the existence of a peri-ureteritis; yet, thanks to the ureteral catheter, it was possible to re-sect it without injury; this was done for a distance of about seven centimetres, leaving the peritoneal covering, which was already attached to it by the inflammatory process on it; besides, this served a good purpose by maintaining vitality. At the vaginal junction the ureter was severed, but the catheter was allowed to remain in it. The bladder was filled about two-thirds full of sterilised water and opened, as nearly as possible to the normal position of the ureteral orifice, by an incision of about three-quarters of a centimetre, the water having been emptied again by catheter as soon as the knife touched the mucosa. A long pair of uterine dressing forceps was passed through the artificial opening in the bladder *per urethram,* and the ureteral catheter drawn through the viscus and out of the urethra, from which it protruded about ten centimetres; next the ureter was invaginated through the opening in the bladder to the extent of about one centimetre. Now three very fine silk sutures were placed at about equal distances, which passed through the entire thickness of the bladder excepting the mucosa and quite superficially through the ureter" (as shown in Fig. 187). "The abdomen was now closed in the usual way without drainage. Recovery was uneventful." The bladder was kept empty by a catheter passed through the urethra alongside the ureteral catheter so as to hasten healing by preventing tension on the graft.

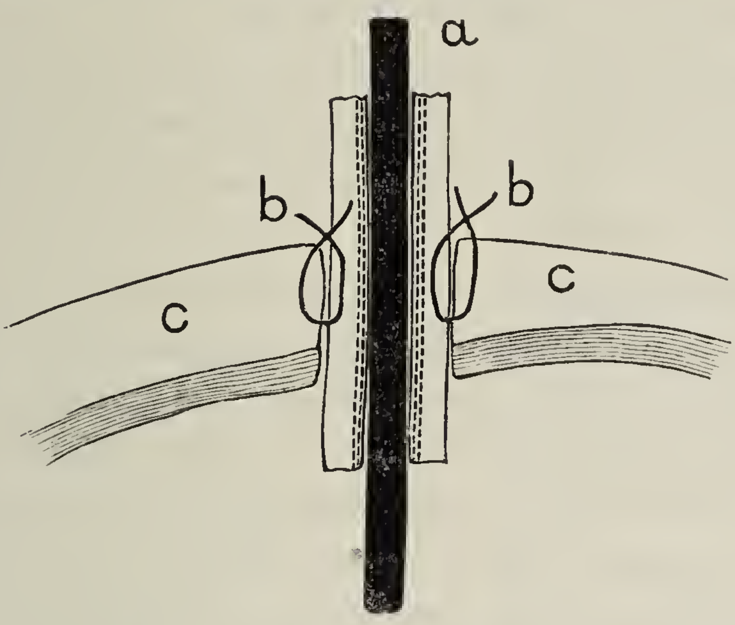

Fig. 187.—Implantation of Ureter into the Bladder: Boldt's Method.
a, Catheter in the ureter; *b*, *b*, sutures fixing ureter to bladder; *c*, *c*, wall of bladder.

Boldt thinks the partial distension of the bladder advantageous in assisting to select the exact spot at which to make the graft.

He attaches the greatest importance to the ureteral catheter as an aid to the surgeon in freeing the ureter from its firm adhesions; indeed he believes that by its means the ureter, though surrounded by tissues altered by peri-ureteritis, could be freed in every instance. The instrument, he further thinks, offers resistance to the traction on the ureter in the event of intestinal peristalsis following upon the operation: it should not be retained longer than forty-eight hours, as by that time the adhesions between bladder and ureter are sufficiently firm.

TUFFIER'S METHOD.—Tuffier,* who had recommended a somewhat similar operation in 1892, had occasion to employ it in 1893 on a woman who had a uretero-vaginal fistula following vaginal hysterectomy for cancer.

He performed laparotomy in the median line, then, with the patient in the Trendelenburg position, he sought for the ureter as it crosses the iliac vessels. Dividing the peritoneum there, and looping up the ureter, he made traction on it, so that it was felt by the finger of an assistant passed into the vagina to drag on the vaginal wall. Thus being sure of the ureter, he continued his dissection as far as the vaginal *cul-de-sac* and there cut the ureter close to the vagina; then having drawn the ureter into contact with the right postero-lateral wall of the bladder he made a vertical incision 1 cm. long, through the bladder. By means of a No. 12 catheter, one end of which was passed into the ureter and the other through the vesical opening and out at the urethra, he drew the end of the ureter against the bladder and sutured the orifice of the ureter to the bladder by five catgut sutures for the mucous membranes, and by a row of silk sutures for the musculo-fibrous tissues of the bladder and ureter. The patient made a good recovery.

The application of Van Hook's sutures to cysto-ureterotresis by the trans-peritoneal method.—Dr. J. M. Baldy of Philadelphia, in December, 1895, employed the Van Hook stitch to implant the cut ureter into the bladder.†

The injury occurred in the course of enucleating an intraligamentous cyst, complicated by dense pelvic adhesions and pyo-salpinx. After the diseased parts and the uterus had been removed, the bladder end of the ureter buried in inflammatory deposit could not be found, but the other end was discovered amongst a mass of shreds well above the ilio-pectineal line in the false pelvis.

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* Duplay and Reclus, *Traité de Chirurgie*, vol. vii., pp. 462, 463.

† *Amer. Journ. of Obstetrics*, March, 1896, and *Annals of Surg.*, xxiv., 1896.

Two double catgut sutures were made to perforate the ureter at points an eighth of an inch from its end. By them the end of the ureter was drawn into the bladder through an incision one inch long made at the point where its wall could be most easily brought into contact with the ureter. These sutures were made to penetrate the bladder walls from within outwards, an eighth of an inch from the incision, and to protrude from its peritoneal surface, and were then tied. The mucous membrane of the bladder was now united by a continuous catgut suture, then the connective tissue, and finally the peritoneum were stitched by separate continuous catgut sutures. Care was taken to run each suture through the outer coat of the ureter as it passed by it, for the sake of more accurately closing the wound about the ureter, and more certainly safeguarding the ureter from being pulled from its position. In order to relieve all tension on the ureter two stout catgut stitches were made to fix the bladder securely to the pelvic wall at the point of the stump of the ovarian artery. Peritoneum was brought over all the denuded parts of the pelvis, a glass drainage tube was introduced, and the abdomen closed. The patient recovered, and a cystoscopic examination of the bladder subsequently revealed that urine flowed from the ureteral opening, which projected above the surrounding level of the bladder mucous membrane. Dr. Baldy mentions that he had assisted in two similar operations, both of which proved successful.

Penrose and Krug have grafted the ureter into the bladder as a primary operation for injury done to the canal during abdominal operations, by the same method that Van Hook recommends for implanting the upper into the lower end of the divided ureter. In sewing up the incision in the bladder care must be taken to prevent leakage without constricting the lumen of the ureter.

Dr. Charles B. Penrose,* during the performance of an abdominal hysterectomy in which the ureter was injured, implanted its proximal end into the bladder. The patient was a woman, aged forty, with scirrhous carcinoma of the whole length of the cervix uteri; the left broad ligament being infiltrated by a dense hard mass to a distance of about one inch from the cervix. The left ureter passed directly through this hard mass in the broad ligament. Cœliotomy was performed in July, 1893. "After the ureter had been cut away at the vaginal junction, the distal end of the ureter was ligated with silk; the vagina closed; the peritoneum was sutured over the seat of operation as much as possible; and the proximal portion of the ureter was then implanted into the body of the bladder. The operation was similar to and was derived from that used by Dr. Van Hook for uniting a ureter after complete transverse division, by lateral implantation of the proximal into the distal portion.* An incision was made antero-posteriorly in the body of the bladder somewhat less than one-half in length. A needle armed with fine silk was passed through the bladder wall from without at a point about one-third of an inch from the edge of the incision on the right, and brought out through the incision. It was then passed through the right wall of the ureter close to the extremity, carried back through the incision in the bladder, and passed through the bladder wall from within out close to its point of entrance. A similar suture was passed on the left side of the incision in the bladder, and through the left side of the wall of the divided ureter. Traction on these sutures dragged the ureter into the bladder, and when tied they held it in position. The loose peritoneum, which formed a partial investment of the ureter, was drawn down and sutured to the peritoneum of the bladder by a continuous silk suture around the line of union of the ureter with the bladder. The abdomen was closed without drainage. A soft rubber catheter was introduced through the urethra and was retained for three days. The patient made an unusually easy recovery. There were no symptoms of vesical or renal disturbance."

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* *Med. News*, Philadelphia, April 28th, 1894, p. 470.

Florian Krug † reported the following case:—

The ureter was accidentally divided by him in the course of a complicated abdominal hysterectomy for uterine fibroid.

The distal end of the ureter was tied off. The proximal end, spilt so as to widen the orifice, was then sutured to the bladder at an incision 1½ inches long made near the vertex by two sutures, placed opposite to one another. The sutures, consisting of fine catgut, were introduced after Van Hook's method, as in Penrose's case.

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* *Journ. Amer. Med. Assoc.*, March 4th, 1893.

† *New York Journal of Obstetrics and Gynecology*, 1894, p. 495, and *American Gynecological and Obstetrical Journal*, 1894, vol. vi., pp. 489–494.

Krug made four tiers of running sutures and strengthened the graft by suturing all the available peritoneum about it. A catheter was retained in the bladder for four days and used every four hours for two days more. Recovery followed.

Boari's button.—Boari * has proposed the employment of an anastomising button, after the plan of Murphy's button, for the engrafting of the ureter into the intestine. A button, something like Murphy's button, can be adapted to the ureter owing to the dilatability of the walls of this slender canal. The button of Boari (Fig. 188) consists of a tube with two plates, one of which is fixed at one end of the tube; the other is kept level with the other end by a spiral spring wire, but can be made to

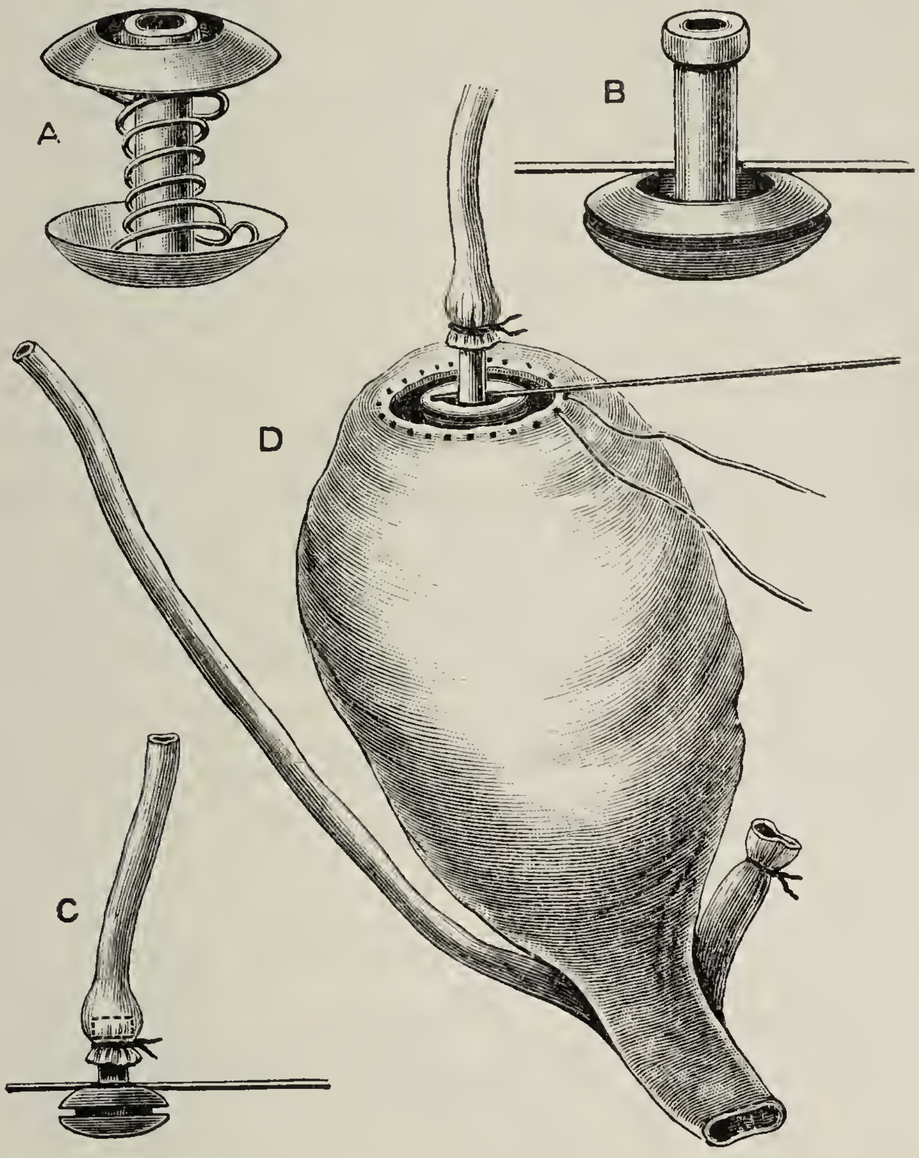

Fig. 188.—Technique of the grafting of the Ureter on to the Bladder with Boari's Button.

A, Enlarged view of button; B, enlarged view of button, showing the spring compressed by the stiletto; C, the ureter fastened on to the button; D, the grafting of the ureter on to the bladder by means of the button.

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* *Ann. des Malad. des Organ. génito-urinaires*, 1896, p. 1.

slide along the tube and come into apposition with the first plate by compressing the spiral coil. The tube is fastened into the ureter, and the other end, with the two plates in apposition, fastened within the opening into the bladder; and as soon as this is done the upper plate is allowed to spring back to the end of the tube now fixed into the ureter, and the bladder wall is thus brought into contact with the ureteral wall. To make the union more secure several sutures are employed to fix the perivesical tissue to the tissue around the ureter.

The ureter is sought for through a laparotomy incision, and detached by cutting upon it through the posterior parietal layer of the peritoneum. The actual grafting can be done extraperitoneally by the method of Novaro. The button is extracted through the dilated urethra of the female or by cystotomy in the male. Calderini of Bologna, for a uretero-uterine fistula; Chalot of Toulouse, for a wound of the ureter made in the course of a hysterectomy for cancer; Bertazzoli, in two cases for uretero-cervico-vaginal fistulæ; Pestalozza, for a utero-vaginal fistula following a hysterectomy; and Umberto Chiaventone, in a case of ureteral fistula,* have each had successes with this button of Boari. The function of bladder and kidney has been perfectly restored in all these cases.

In Bertazzoli's cases the pelvic peritoneum was sutured over the point of grafting, no drainage was employed, and the wounds healed by first intention. †

C. VAGINAL CYSTO-URETEROTRESIS.

Kolpo-cysto-ureterotresis, or vaginal cysto-ureterotresis, embraces a large variety of operations, the aim of each being to deflect an abnormal (fistulous) orifice from the vagina into the bladder through the vesico-vaginal septum.

The two classes into which I have grouped these operations are—

1. Grafting the entire fistulous orifice into the bladder.
2. Obliterating the fistulous orifice by making a new communication between the end of the ureter and the bladder.

1. Methods of grafting the entire fistulous orifice into the bladder.—P. Segond ‡ in a case of uretero-vaginal fistula of the right ureter, the vaginal orifice of which was widely gaping, passed a long slender bougie to make sure of his diagnosis. He next freshened the mucous membrane underneath the vaginal orifice of the fistula; then he fixed at this level a flap cut out of (*lambeau taille*) the *bas fond* of the bladder. The ureter was thus transplanted into the bladder by the vesical diverticulum so formed. Complete recovery was the result.

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* *Ann. des Maladies des Org. gén.-urin.*, Mai, 1900, p. 507.

† *See* article by Boari, *Ann. des Maladies des Org. gén.-urin.*, 1899, p. 1141 *et seq.*

‡ *Bull. et Mém. de la Soc. de Chir.*, 1895, t. xxi., p. 275.

Mackenrodt* has obtained two successful results by a procedure similar to Segond's.

A sound introduced into the urethra is made to project the vesico-vaginal wall immediately at the side of the fistula. The wall is cut transversely, on this level, to an extent of from 2 to 3 cm. The fistula is then circumscribed by a deep incision which embraces the whole thickness of the vaginal wall. In this way is formed a flap of the shape of a myrtle leaf, in the centre of which the fistula opens. This flap is dissected as far as the fistula, and is then turned up, so that its vaginal aspect becomes intra-vesical. The edges of the flap are next sutured to those of the vaginal wound, and the wound itself is then closed.

Mayo,† after isolating the ureter by dissecting around the vaginal fistula, fixed the fistulous orifice so set free by some points of suture against the vesico-vaginal wall. After some weeks, when the union between the ureter and bladder wall was secure, Mayo freshened the orifice of the ureteral fistula, incised the bladder to a suitable length, proportionate to the ureteral orifice, introduced by the urethra a rigid catheter, which, coming out at the vesico-vaginal wound, was introduced into the ureteral fistulous opening. The wound was then sutured around the catheter, which was left *in situ* during healing.

Max Schede, in "The Operative Treatment of Uretero-vaginal Fistula,"‡ describes a method of his own. He operates at two sittings.

In this operation the first step is the establishment of a vesico-vaginal fistula, which must be established in such a way that the orifice of the ureter forms its extreme posterior end. An oval-shaped portion, about 2 cm., was cut out of the vesico-vaginal wall, its longitudinal diameter being obliquely forwards and to the right, somewhat in the direction of the normal course of the lower portion of the ureter. Hard cicatricial tissues were encountered which later made freshening and suturing difficult; a perfectly transverse excision appeared to threaten the danger of injuring the other ureter. To guard the artificial fistula, which just permitted entry of the fore-finger, from spontaneous stenosis, the vesical and vaginal mucous membranes were sutured together circularly in a lip-shaped manner, as Hahn had already done. Further proceedings were deferred till after healing of the vesico-vaginal wound.

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* *Zeit. f. Geb. u. Gyn.*, 1894, Bd. xxx., p. 310.

† *Minn. State Med. Soc.*, quoted by A. Boari.

‡ *Centralblatt f. Gynäkologie*, 1881, No. 23, p. 547.

Fourteen days later the operation was concluded. An elastic catheter was introduced on the one side into the ureter, on the other it was passed through the artificial fistula into the bladder and brought out through the urethra. Then the area all around the fistula to the extent of some 5/4 cm. was superficially freshened, care being taken to leave a strip of vaginal mucous membrane 3–4 mm. in breadth quite intact in the immediate neighbourhood of the orifice of the fistula. (Fig. 189.) The corresponding wound surfaces were sutured together, and by this means the edges of the fistula, covered with intact mucous membrane, were turned inwards to the bladder, and here formed a deep gutter wholly lined with mucous membrane, in the outer or posterior end of which the ureter opened. A satisfactory cure was at length obtained. This arrangement Schede thought had the following advantages: The walls of the ureter remained quite uninjured, and thus there was no further cause given for cicatricial shrinking and stenosis of the ureteral orifice; the artificial

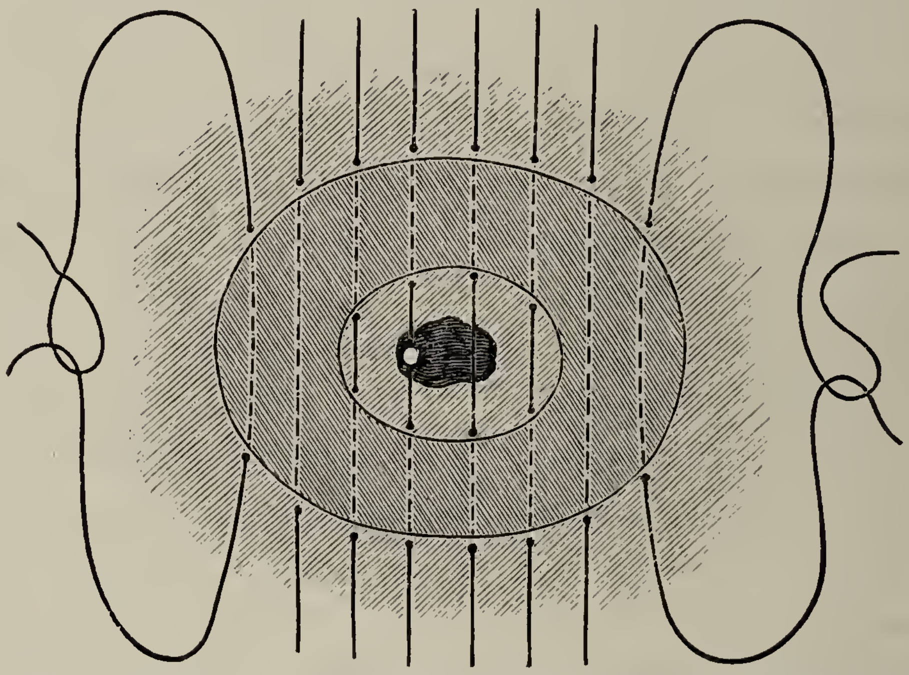

Fig. 189.—Operation for Uretero-vaginal Fistula: Schede's Method.

or gutter-like semi-canal would prove of great value as a passage for urine; and catheterisation of the ureter might be effected as occasion might demand.

Trélat* has twice had recourse to a procedure like this of Schede's, but without employing the ureteral catheter. Indeed, as the ureteral orifice by Schede's method of operating is surrounded by mucous membrane, there seems no need to employ the catheter, and no absolute necessity to divide the operation into two stages, though it is probably safer to do so.

Procedure of Pozzi † for splitting the vesico-vaginal septum for uretero-vesico-vaginal fistula.

The patient being in the genu-pectoral position, local anæsthesia by cocaine is obtained. The vagina being widely opened and the uterus dragged down, a vertical incision is made on the level of the fistula extending above and below it for about 1 cm.; then a transverse incision at each end of the vertical incision gives it the form of the letter **H** turned sideways (Fig. 190).

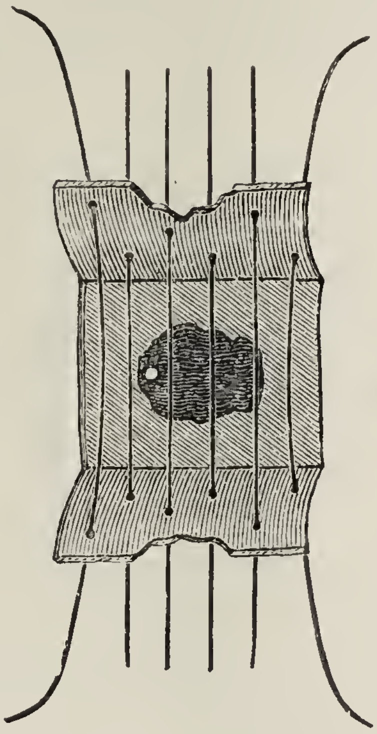

Fig. 190.—Operation for Uretero-vaginal Fistula: Pozzi's Method.

The borders of the vertical incision are dissected up to the extent of 2 cm. in such a way as to obtain two small flaps by splitting of the vesico-vaginal septum. When these flaps are raised the small fistulous orifice is seen in the centre of the bleeding surface. The deep aspects of the two flaps are brought together face to face in front of this orifice, and are carefully united with three deep sutures of silver wire and four superficial sutures. Thus after the sutures are fixed there is in place of the fistulous orifice a small crest projecting on the vaginal surface. The sutures are removed on the eighth day. The result is described by Pozzi as a complete cure. If the fistula is very large, and the splitting of the septum extensive, fishing gut and perforated shot might be used for the flaps.

Herrgott of Nancy ‡ reports a case of uretero-vesico-vaginal fistula involving the left ureter in which he employed a method which is in principle the same as Pozzi's. By splitting the septum on the side where the fistulous orifice was situated, he detached and pressed up into the bladder 1 cm. of the ureter.

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* *Bull. et Mém. de la Soc. de Chir.*, Fév. 23, 1887, t. xiii., p. 117.

† *Bull. et Soc. Mém. de Chir.*, Fév. 25, 1887, t. xiii., p. 114.

‡ *Ann. de Gyn.*, Juin, 1888, t. xxix., p. 408.

When the exact position of the ureteral orifice is known, the splitting of the septum may be limited to the margin on which the ureter opens; but if the ureteral orifice cannot be exactly located, it is best to split around the whole circumference of the vesico-vaginal fistula.

Arie Geyl,* following the method of Kaltenbach, made a connection between a uretero-vaginal fistula and the bladder by establishing a permanent vesico-vaginal fistula, and then removing an oval strip of vaginal mucous membrane surrounding these two fistulæ, and approximating the denuded surfaces.

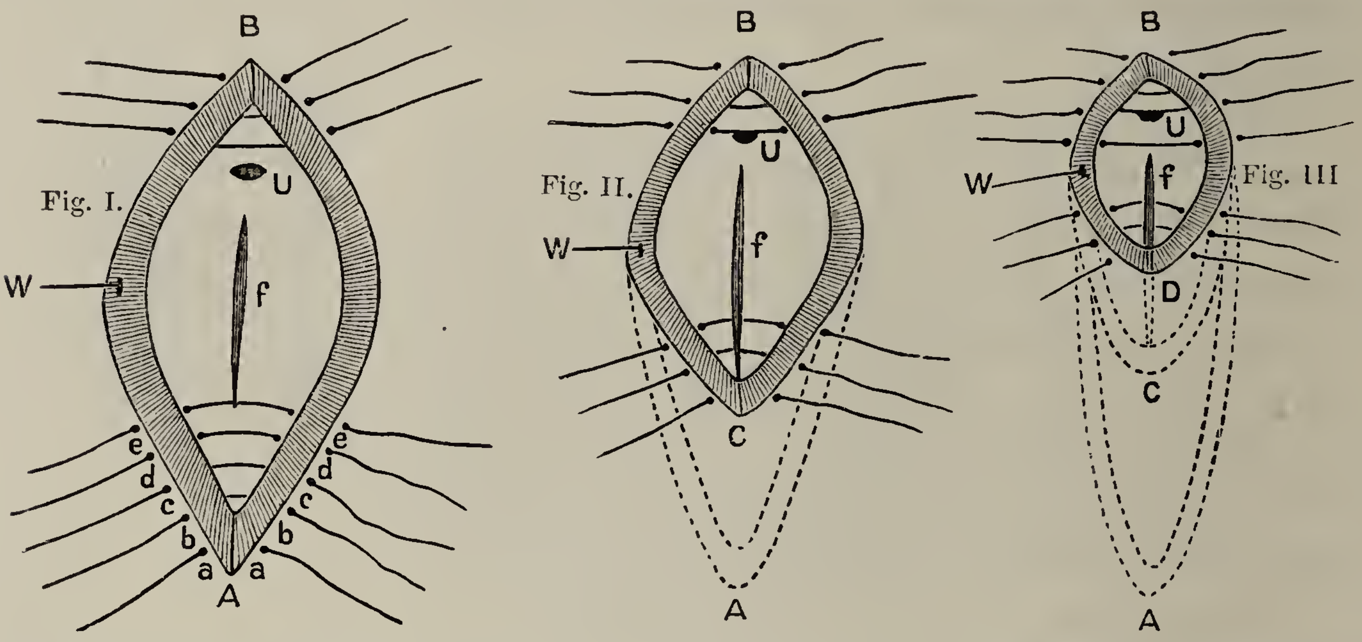

Fig. 191.—Kaltenbach's Operation for Ureteral Fistula. Two stages of operation: (1) The establishment of a vesico-vaginal fistula; (2) Closing-in of a tunnel in which are contained the ureteral and visical fistulæ.

Fig. I.—B A, Raw surface in vaginal mucous membrane enclosing the ureteral fistula, U, and the artificially produced vesico-vaginal fistula, *f*, in its near neighbourhood. A, B, C, D, E, sutures approximating corresponding raw areas and only passing through the mucous membrane on each edge. Figs. II. and III. show the loculus half and three-quarters respectively, closed in, so as to include the ureteral and vesico-vaginal fistulæ in a pouch of mucous membrane.

After one week of careful disinfection of the uterine cavity, the patient, being anæsthetised, was placed in the lithotomy position. Pawlik's catheter was passed up 6 cm. into the ureter and given in charge of an assistant. The bladder was distended with boracic acid solution, and a staff passed into it and held so that its groove was towards the vagina, and the point touched Pawlik's catheter. An incision was then made upon the groove of the staff through the vesico-vaginal septum, without wounding the fistula, but commencing in its immediate neighbourhood. This incision was 2 cm. or less in length. A small metal catheter was introduced through the urethra and

* *Sammlung klin. Vorträge*, Jan. 1892, No. 37; *Gynäkologie*, No. 14.

bladder, and thence through the wound into the ureter, and was held in this position during the remainder of the operation. The catheter was given a slight **S**-shaped curve before introduction.

Second stage of operation.—Commencing at a point $\frac{1}{2}$ cm. beyond the ureteral opening, Geyl then removed two strips of mucous membrane in an oval, including the ureteral orifice and the vesico-vaginal fistulous opening, and 1–1$\frac{1}{2}$ cm. of intact mucous membrane around them. These raw surfaces are brought together and sutured so as to form a tunnel of mucous membrane by means of which the ureteral fistula communicates with the opening into the bladder.

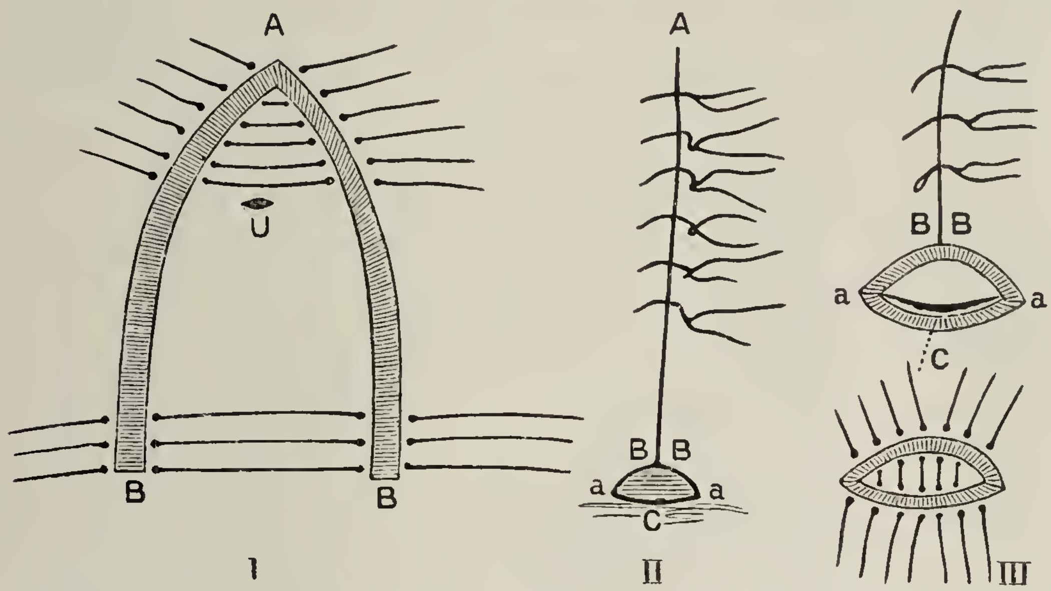

Fig. 192.—Geyl's Modification of the Operation of Kaltenbach.

I.—A, B, B, Raw surfaces in mucous membrane; U, ureteral fistula. II.—a, B, B, a, Free edge of *cul-de sac;* C, placed on site of vesico-vaginal fistula (artificial), which is a transverse incision. III.—a, B, B, a, Freshened free edge of *cul-de-sac;* C, edge of wound into bladder. Below, the sutures are seen passed through this edge and also through the freshened edge of the end of the tunnel.

Geyl remarks that such operations often fail through entanglement of the ureter in a suture. Pawlik advises against operation, unless by the eye or the sound the position of the ureter is made out.

An ample portion of vaginal mucous membrane should be left around the bladder aperture, after the parts are drawn together.

Geyl suggests modifying the oval dissection by a plan of his own (shown in Fig. 192) as follows:—

Strips of mucous membrane are dissected off around the ureteral fistula, as in the proceeding described above, but the lower extremities do not meet. These raw surfaces are thus brought together by sutures, forming a tunnel enclosing the orifice of the ureteral fistula and having a free opening below. On a level with this opening, that is through the base of the free end of the tunnel, a transverse incision is made into the bladder —an artificial vesico-vaginal fistula in fact. The free edge of the roof of the tunnel is then denuded of mucous membrane and united by sutures to the lower lip of the vesico-vaginal fistula, thus closing the tunnel and establishing a permanent opening between it wherein is the opening of the ureteral fistula, and the bladder.

Leopold Landau, writing on "The Pathology, Diagnosis, and Treatment of Uretero-vaginal Fistula,"* gives the following methods of operating:—

1. A vesico-vaginal fistula is first made by excising an oval strip of the vesico-vaginal septum; a long slender elastic catheter is then introduced into the upper segment of the ureter from the vagina; the free end of this catheter is conducted through the lower end of the ureter into the bladder, and thence, by means of a pair of dressing forceps, drawn out through the urethra. Now, in the knee-elbow position, in which, Landau says after long experience, all these manipulations are found to succeed easily, the vaginal mucous membrane all around the vesico-vaginal opening (through which one can now see the catheter) is freshened, and the raw surfaces are brought into apposition by means of sutures passed at right angles to the direction of the ureteral catheter (Fig. 193).

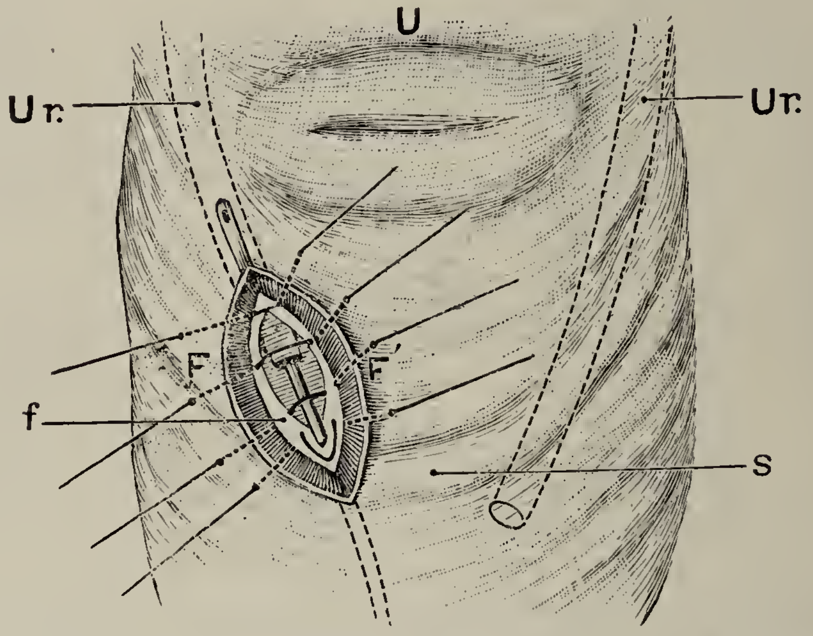

Fig. 193.—Operation for Uretero-vaginal Fistula. Landau's Method.

U, Os uteri; Ur., line of ureter on each side; S, middle point of anterior vaginal wall; F, F′, margins of opening in the vesico-vaginal septum; *f*, one of the sutures crossing at right angles with the catheter, which traverses the urethra, bladder, and lower end of the ureter. The fine lines indicate sutures.

The catheter is allowed to remain in position for some days. Bandl has successfully employed this method in two cases. If this method is not successful, Landau recommends that the following should be tried in those cases where the end of the ureter is obliterated.

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* *Archiv. f. Gynäkologie*, ix., 1876, p. 434.

2. On a catheter being introduced as above into the upper segment of the ureter, an incision is made in the direction and for the length of the lower segment of the ureter into the bladder through the middle and upper-third part of the vaginal septum. On both sides of this incision a strip (0.5 cm. broad) of the vaginal and vesical mucous membrane is removed so that a longitudinal oval is formed. If the distal end of the ureter is obliterated, an incision is made along its whole length, and the free end of the catheter is passed into the bladder and out through the urethra. In this way the direct uretero-vaginal fistula is converted into the usual vesico-vaginal fistula, into the uppermost portion of which the ureter opens. Deep sutures reaching to the bladder are now applied at right angles to the long axis of the fistula. Recovery takes place as in ordinary vesico-vaginal fistulæ (Fig. 193).

2. **The methods of direct obliteration of the fistulous orifice.** —(*a*) *The procedure of Simon.**—An incision through the vesico-vaginal septum is made by the side of the uretero-vaginal fistula. A grooved director is passed through this opening into the ureter, and also through it the ureter is laid open in an upward direction to the extent of from one-third to half an inch so as to convert this extent of the intra-vesical ureter into a gutter or groove. The edges of the split ureter are separated every day by means of a director, so as to prevent their growing together. As soon as their cicatrisation is completed, the margins of the vesico-vaginal fistula are vivified by paring them widely, and the freshened surfaces are united by transverse sutures. The newly formed ureteral orifice will open into the bladder at some little distance from the vesico-vaginal cicatrix.

(*b*) *The procedure of Duhrssen.*†—A director is introduced into the ureter through the fistulous opening. An oblique incision is then made upon the vaginal wall passing through the fistula, and the two edges of the wound are dissected away. Then the bladder is opened to a slight extent along the outer side of the fistula, and the septum between the ureter and bladder is divided. The mucous membrane of the ureter is then sutured to that

* *Wien. Med. Woch.*, 1876, No. 28, p. 692.

† Volkmann's *Samml. klin. Vortr.*, 1894, No. 114, p. 273.

of the bladder so as to establish a free opening of communication between the ureter and bladder. The vesico-vaginal opening made to allow of the performance of this operation is then closed by sutures.

Tuffier,* in a case of uretero-vaginal fistula following vaginal hysterectomy, which had existed six months, made a wide incision embracing half the circumference of the outer part of the fistula, so as to mobilise the ureter. He then freshened an extensive surface of the internal vesical part of his fistulous opening, and used a double row of sutures to graft the ureter into the bladder—the uretero-vesical sutures were of catgut, and the seven vaginal sutures of fine silk. In this case there was a small vesico-vaginal fistula at the top of the vagina on the right side, and a funnel-like ureteral fistula on the left.

Tuffier says whatever method is chosen, the first precaution must be to abolish any stricture at the inferior end of the ureter. The method of closure appears to him to be the implantation of the ureter into the bladder by the vaginal route, and he gives the following stages in the operation:—

(*a*) Free the ureter, bring it down as far as possible, and split it for the length of 1 cm., and introduce a soft catheter into it, the other end of which will be made to pass through the bladder and out at the urethra.

(*b*) Introduce a flexible sound into the bladder, and press it against the lateral part of the vesical wall at a point most easily accessible for the end of the ureter involved; and make a triangular opening at this point into the bladder.

(*c*) Unite by catgut suture the mucous membrane of the ureter with the mucous membrane of the bladder, and by means of silk sutures the muscular coats of the ureter and bladder.

The operative procedure devised by T. A. Emmet† is on the same principle as the foregoing.

Emmet formed a channel out of vaginal tissue to carry the urine from the ureteral fistula to a point well beneath the bladder, "intending" (to complete the operation of kolpo-uretero-cystostomy) "to turn the new opening of urinary discharge into the bladder by a temporary vesico-vaginal fistula"; but the patient died of pneumonia between the stages of the operation. His account of the operation is very confused and difficult to follow

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* *Bull. et Mém. de la Soc. de Chir.*, 1895, t. xxi., p. 270.

† "Principles and Practice of Gynæcology," 1879, pp. 642 and 888.

In another case he closed the ureteral opening into the vagina and utilised an old abscess track for conveying the urine from the left kidney into the bladder.

A married woman, twenty-one, sterile, suffered from a pelvic abscess the result of a fall, and subsequently the urine escaped freely by the vagina.

Emmet made a long vesico-vaginal incision, and through this found that the right ureter was normal; the left, in its bladder part, was closed by a septum about an inch above the vesical orifice. The pelvic abscess had caused an opening in the bladder, which communicated also with the vagina. Emmet thought it would be dangerous and useless, because of the curved and abnormal directions of the vesical and the renal parts of the ureter to one another, to open through the septum in the vesical part of the ureter; but that it would be possible to safely close the opening of the ureter into the vagina, and so turn the urine from the left kidney into the bladder through the track of the old abscess. This was ultimately done with success.

THE SACRAL METHOD.

Kraske has used the sacral route for uretero-vesical grafting, and has been followed by Vincini (A. Boari) in 1893, and Westermarck in 1896.* Both Vincini's and Westermarck's operations were done for wounds of the ureter inflicted during the course of hysterectomy for cancer by the sacral route. Both cases ended in recovery.

Schede (A. Boari) in 1890 also sutured the ureter to the bladder on account of a wound caused during extirpation of the uterus by the sacral way; but the operation failed.

Abbe † through a sacral incision sutured the injured ureter of a man into a foul vesical pouch. This pouch had been mistaken for an abscess with indurated walls, and Abbe unsuccessfully attempted to remove it by the sacral way (by a Kraske operation) and injured the ureter in the attempt. The patient recovered without any leakage into the wound; and the vesical pouch shrank and became aseptic.

This method, however, cannot be recommended except in cases in which the ureter is injured in the course of an operation performed by the sacral way. The discovery of the ureter may be very difficult, and the depth of the space is often very great, and not convenient for the delicate operation of suturing the ureter to the bladder.

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* *Ann. of Surg.*, 1896, p. 338.

† *Ann. of Surg.*, No. 20, 1894, p. 183.

GENERAL CONSIDERATIONS ON URETERO-VESICAL GRAFTING.

Grafting the ureter into the bladder, if successful—and the operations hitherto have been remarkably so—re-establishes a natural state of things physiologically, conserves the kidney, and cures or avoids a fistula.

Of the several methods which have been described, the best to adopt depends upon the special conditions of each case. With regard to the treatment of fistulæ this question is discussed in Chapter XIII. (p. 512 *et seq.*).

The extra-peritoneal grafts are certainly safer than, and therefore to be recommended before, the intra-peritoneal.

The objections which have been taken to *vesical grafting* as the method of choice in the treatment of complete division of the ureter in its lower portion, or for fistula opening on the abdominal parietes, is that it can only be applied to those cases in which the injury is very close to the bladder, as much traction on the ureter is hostile to good union, and tends to diminish the calibre of the canal, and thus to induce hydro-nephrosis. Baldy's and Kelly's procedures, and other methods described in the foregoing pages, are designed to meet this objection to a certain degree.

There are other objections which apply to this treatment, equally whether employed for uretero-uterine and uretero-vaginal fistula or for immediate injuries. These are : (1) Stenosis, which is apt to occur at the site of implantation, and (2) the risk of renal infection by ascending septic processes. The objection on the score of stenosis is invalid in cases of vaginal fistula with a free orifice, if the method of implanting the entire orifice is employed.

1. The liability to stenosis is owing to the mode of uniting the ureter by passing it through the bladder wall directly, instead of obliquely as it passes naturally.

This is overcome by splitting the end of the ureter before uniting it to the bladder, as Küster did in uniting the ureter to the renal pelvis. By so doing the new vesical orifice of the ureter is widened, and there is little or no fear of contraction.

2. The risk of infection of the kidney from the bacillus coli communis so frequently found in the diseased bladder, and from other micro-organisms which are present in the urine, especially after the employment of instruments, certainly exists in all cases, but is not great if the patient's health is sound, the bladder healthy, and strict asepsis is secured. This risk is due to the loss of the valve-like opening of the natural ureteral orifice, and the substitution for it, by grafting, of an opening which is always patent except when constricted by the contraction of the muscular coats of the bladder through, but not obliquely between, which it passes.

If the bladder remains uninfected and the urine in it healthy, there is no reason why the kidney should be endangered. On the contrary, even when pyuria is present vesical grafting ought to supersede nephrectomy for uretero-vaginal or other fistulæ; and the grafting should be done with the hope that by re-establishing the natural course for the urine through the bladder, the renal infection will disappear, as was the case with patients operated upon by Bazy and Rouffart.

In proof of the danger of a reflux of urine through an artificial ureteral opening, it may be stated that Desnos, Modkinsky, and Pozzi report cases of leakage of urine from the bladder through the vesical end of a divided ureter; and Hartmann has seen the same thing after nephrectomy. The risk arising from this cause in cases of injury, when the part below the division is left connected with the bladder, is very easily prevented by applying a ligature to the ureter. In intra-peritoneal operations the best precaution is burying the stump, and stitching the peritoneum over it after ligaturing it.

It is possible that a method of suturing the ureter to the bladder in imitation of the normal oblique course of the ureter through the vesical wall, will be found to obviate regurgitation along the engrafted tube.

The plan first employed by Lannelongue and then by Bazy of keeping a catheter in the ureter for some days during the healing, assists union and prevents the contact of the graft with the urine and the tendency to stenosis of the new orifice during the cicatrising process. Bazy's results have been very good. The results obtained experimentally and clinically with Boari's button have been good. The button facilitates and expedites the operation; the disadvantage attending its employment resides in the necessity of dilating the urethra in the female and performing a cutting operation in the male to remove the button. It will doubtless be found most useful when the operation must be done quickly, as at the end of a long hysterectomy or ovariotomy during the course of which the ureter has been cut.

The vesical graft is not so apt to be followed by those troubles of renal infection which occur after uretero-intestinal grafting; nor has hydro-nephrosis from stenosis of the new ureteral orifice been observed as a result, though Pozzi has seen a certain degree of renal dilatation attributable to reflux of urine up the ureter due to vesical distension. This could be avoided probably if the ureter were grafted into the summit of the bladder; or less certainly by grafting the ureter obliquely in the substance of the bladder wall, as Büdinger and Colzi have done, and as Chaput has done in uretero-colic grafting.

CHAPTER XVII.

PLASTIC OPERATIONS ON THE URETER

(*Continued*).

DIVERTING THE COURSE OF THE URETER BY GRAFTING ITS DIVIDED END ON TO THE SKIN OR INTO THE INTESTINE.

I. IMPLANTATION TO THE SKIN, OR DERMATO-URETEROTRESIS.

IN certain cases—where there is only one kidney, or only one sound kidney—nephrectomy is of course out of the question; and if the ureter of the single or only sound organ is injured under circumstances in which it is impossible or unadvisable to attempt uretero-ureteral anastomosis or uretero-vesical grafting, the establishment of a fistula on the loin or at some other part of the external surface becomes almost imperative. The alternatives would be grafting into the bowel, or restoring the course of the urine to the bladder by some form of "splice."

Implantation of the proximal cut end of the ureter into the skin is a very simple procedure. The end of the duct is brought out of the wound, split by a single incision one-third of an inch long to enlarge the opening, and the split extremity is then carefully sutured to the edge of the skin by five or six fine silk sutures. Care must be taken that the ureter is not twisted or too sharply bent upon itself in bringing it into its new situation.

Le Dentu,* in 1889, performed this operation on a female aged thirty-three, both of whose ureters were compressed by a mass of recurrent new growth. He made a long oblique incision in the left flank and exposed the ureter in the iliac fossa down to the brim of the bony pelvis. The ureter was distended with urine and was seen in the depth of the wound as a grey cord. After isolating it carefully, he applied two pairs of torsion forceps across it, the lower one as low down as possible, and divided the tube between them. He then drew out the upper segment of the ureter and fixed it near the upper extremity of the parietal incision by four sutures. The wound was drained, and an india-rubber tube inserted into the end of the ureter conveyed the urine across the dressings into a urinal placed by the side of the patient. An abundant flow of urine followed, and continued up to the patient's death thirteen days later from the extension of the effects of the cancer from which she was suffering.

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* "Affections Chirurgicales des Reins et des Urétères," p. 803.

Albarran examined the kidney after death, and found an entire absence of any morbid change in it beyond an insignificant degree of sclerosis; and no evidence of any ascending infective uretero-pyelo-nephritis.

Le Dentu gives a figure showing the ureter passing in a uniform curve round the lower end of the kidney up to the skin of the flank. Though the lower part of the kidney covers and is adherent to the ureter the lumen of the duct is quite free.

Pozzi* has performed the same operation, but grafted the ureter to the skin of the loin farther back than Le Dentu had done. During the course of an operation for the removal of a par-ovarian cyst Pozzi tore the right ureter at a point 10 to 15 cm. from the renal pelvis. At once rejecting nephrectomy, he sutured the end of the proximal portion of the ureter to the skin of the loin. A tube to conduct the urine was worn in the ureteral orifice for fifteen days, by which time the fistulous opening was firmly established and the tube was withdrawn. The operation was performed on November 10th, 1890, and nephrectomy followed at the request of the patient on February 10th, 1891. The kidney, after removal, was examined by Albarran, who found the greater part of it quite normal, with here and there evidence of slight interstitial nephritis—a condition which was not attributable to the implantation. There were no pyogenic micro organisms in the kidney. The ureter and renal pelvis were normal. Pozzi comments on the absence of infection after *cathetérisme en demeure* of the ureter and a long period of fistulisation.

Trekaki, in his thesis,† gives an account of Le Dentu's and Pozzi's cases, and of the experiments which have been performed on dogs, and he recommends the operation in cases in which the ureters are compressed by myomata and other tumours which cannot be removed. He considers that inflammatory conditions of the kidney not too extensive will be recovered from after obstruction is removed by means of this operation.

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* *Ann. des Mal. des Org. gén.-urin.* Avril, 1891.

† "Du Méat Urétéral Artificiel (Greffe de l'Urétère à la Paroi Latérale ou Postérieure de l'Abdomen"), Paris, 1892.

The following is Bardenheuer's case of grafting the divided ureter to the skin. It is reported by Thelen.* The patient aged twenty-seven, who had been suffering from spasmodic stricture, became the subject during an attempt at dilatation of the urethra of an accidental fracture of an elastic catheter, a portion of which passed into the bladder. Violent cystitis was excited and an abscess formed in the left iliac fossa. The abscess, opened with antiseptic precautions, was behind the peritoneum and connected with the pelvis of the kidney. It was almost entirely healed in five weeks, when suddenly rigors and suppression of the urine occurred. The catheter brought away only mucus and a small calculus. Destruction of the left kidney and closure of the right ureter by a calculus were diagnosed. Bardenheuer, as the only means of saving the patient's life, determined to remove the calculus, for which purpose an incision was made extending from the eleventh rib to the crest of the ilium. In order to reach the pelvis of the kidney and the ureter it was necessary to detach the anterior border of the kidney from its cushion of fat by the hand. The instant the stone was felt in the ureter it slipped back into the pelvis of the kidney, and the flow of urine through the ureter showed that the passage between the bladder and the kidney was free. In order to maintain this favourable position of the organ as long as possible the kidney was drawn backwards and outwards so that the pelvis was visible at the bottom of the wound. An incision was made into the commencement of the ureter, a calculus the size of a bean and four small pieces were removed, and the operation was concluded by sutures in the edges of the incision in the ureter. The urine, however, passed, not through the ureter but by the wound. Four days later Bardenheuer determined (as the urine continued to trickle out) to divide the ureter, and to fix the upper end in the wound. One month after the operation the urine passed through this artificial ureteral opening; the wound was uniting at parts where the urine did not come into contact with it. The patient, though feeble, was recovering.

In this case one is led to ask, If the ureter was proved to be quite patent by the flow of the urine to the bladder as long as the kidney was held backwards and outwards after the extraction of the calculi from the renal pelvis, why was the kidney not fixed so that the urine could find its way to the bladder?

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* *Centralbl. für Chir.*, No. 12, 1882. (Abstract in *Centralbl. für die med. Wiss.*, December 30 1882.)

Mr. Reginald Harrison* has recently performed a similar operation on the right ureter of a boy aged fifteen with exstrophy of the bladder, having previously removed the left kidney, which was quite healthy, by lumbar incision. The right ureter was grafted into the loin eleven months after the left nephrectomy. The ureter was ligatured near the brim of the bony pelvis and divided above the ligature. The end of the ureter was attached to the loin incision by a single silk suture. There was subsequently a tendency to stenosis and the orifice had to be dilated about once in a fortnight. The kidney became pyo-nephrotic and the patient died at the end of six months. Probably the stenosis might have been avoided by splitting the end of the ureter and employing more sutures to fix it to the skin.

"Surface" grafting the ureter, with its resultant fistula, is only less undesirable and objectionable than nephrectomy; indeed, some patients have undergone nephrectomy to get rid of the fistula, as Pozzi's patient did. It is only in cases of ectopia vesicæ and in those where the ureter of *a single kidney* is blocked that such an expedient can be willingly resorted to; and in my opinion it ought not to be done at all in the case of ectopia vesicæ since uretero-colic grafting has become during the last few years a comparatively safe procedure.† I am unable to follow my friend Mr. Harrison in his reasons for excising a healthy kidney before surface grafting the ureter of the other organ.

II. GRAFTING THE URETER INTO THE INTESTINE.

There are two facts which seem to encourage attempts at grafting the ureter into the large bowel, with the object of avoiding nephrectomy or fistula.

These two facts are (1) that Nature has herself made the ureters and the bowel to open into a common cloaca in certain animals, to wit in all fowls excepting the ostrich; and (2) that in some cases in which a fistulous opening has been established by disease, such as cancer, we find fæces passing through the bladder for a long time without cystitis or suppurative pyelonephritis being caused.

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* "Selected Papers on Urinary Disorders."

† Maydl, *Wien. med. Woch.*, 1896, xlvii., and Herczel, *Centralb. für die Krank. der Harn-und-Sexual Organe*, 1899, p. 563.

I have known this condition to continue for many weeks and to be the cause of very great suffering, and the patients have died worn out by the primary disease; but neither cystitis nor infective uretero-pyelo-nephritis was provoked. The results which have been obtained from experiments on dogs are, however, far from satisfactory, though they have not been so uniformly unfavourable as to leave the same impression on each of the experimenters.

History.—The implantation of the ureter into the rectum in the human subject was first suggested by Roux, and the idea was first put into practice by Sir John Simon on July 5th, 1851, although Simon's operation was not strictly an implantation. Twenty-seven years after Simon's attempt Thomas (now Sir Thomas) Smith, in 1878, grafted the ureters into the colon, each into the gut of its own side. Simon's and Smith's operations were for exstrophy of the bladder. Both failed.

The operation was tried again on man by Küster, in 1891, who, after removing the entire bladder for cancer, grafted both ureters into the rectum. The patient died on the fifth day from purulent peritonitis. The sutures had not held.

Chaput has twice successfully performed the uretero-intestinal implantation into the colon; and Leet has in one case had a similar success.

Chaput,* in September, 1892, in a case of uretero-vaginal fistula following vaginal hysterectomy, in which it was impossible to graft into the bladder, implanted the ureter into the colon. He did cœliotomy for the purpose. The patient recovered, and five months after the operation there were no signs of infection of the kidney. The woman was obliged to empty her rectum of urine mixed with fæces three or four times a day. This, however, is a much more tolerable state than any result that has been obtained by the autoplastic methods, or than that of a patient, for example, who, after successfully undergoing the lumbar grafting, insisted on being relieved of the loin fistula by nephrectomy at the end of three months. Chaput's second patient died three months after the first operation, and on the occasion of (the same day as) the implantation of the second ureter, from shock and suppression of urine.

More recently still a method which is full of promise of good results has been employed by Maydl † in cases of exstrophy of the bladder.

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* *See* Bazy, *Bull. et Mém. de la Soc. de Chir.*, 1893, t. xix., p. 309.

† *Wien. med. Woch.*, 1896, xlvii.

He has excised the vesical trigone together with both ureters, and has implanted them *en masse* into the sigmoid flexure of the colon. He then cut out the remainder of the bladder and closed up the resulting abdominal aperture. Afterwards the urine drained into the bowel; the rectum acquiring a tolerance for its presence and a capability to hold it for several hours. Some twenty-two cases have been operated upon in this manner with only three deaths —due to infection travelling upwards along the ureters from the rectum to the kidneys, in spite of the valvular effect of the obliquely entering ureters upon the natural trigone of the bladder. Fowler,* in a successful case in which he employed Maydl's operation, increased the valvular effect of the ureteral opening by a tongue-like flap of the bowel mucous membrane.

Results of experiments on animals of uretero-intestinal grafting.—The objects of the experimenters have not been always the same, but the results of all have been most unfavourable, although not uniformly disastrous.

Gluck and *Zoller*† were the first experimenters in this direction. They tried total extirpation of the bladder on dogs, turning the ureters into the rectum or on to the skin. All their subjects of uretero-rectal implantation were unsuccessful.

Bardenheuer's experiments consisted in grafting one ureter into the bowel. All his animals recovered from the operation, but when sacrificed showed stenosis of the ureteral orifice and hydro-nephrosis of the corresponding kidney.

Novaro had one success out of three experiments for grafting both ureters into the bowel. The dog which survived retained urine for considerable periods, and urinated *per anum*. Thirty days after operation the kidneys were excised and found to be free from inflammatory changes.

Paoli and *Busachi* ‡ grafted the ureters into the bowel; and in other experiments into the bladder. Stenosis of the ureteral orifice was the common result.

Tuffier § sutured the ureter into the rectum. The animals died of pyelo-nephritis.

Morestin ‖ did the bilateral operation ten times and the unilateral six times. All his animals died of peritonitis, pyelo-nephritis, or hydronephrosis.

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* *Amer. Journ. Med. Sciences*, March, 1898.

† *Berlin. klin. Woch.*, 1881.

‡ Med. Congress of Paris, 1888.

§ *Ann. des Mal. des Org. gén.-urin.*, 1888.

‖ Société Anatomique, 1892.

Tizzoni and *Poggi** excised the bladder of a dog, and sutured the ureters into a loop of bowel which they had isolated at a previous operation. This loop of bowel they grafted to the neck of the excised bladder. By this remarkable experiment they made a substitute receptacle for the urinary bladder.

Bacon's suggestion† was to suture the cut ends of a re-sected ureter into an isolated loop of bowel, which was transplanted into the position of the lost piece of ureter.

Gluck and Zoller's experiments, as also those of Bardenheuer and Novaro, were made it is true with reference to excision of the bladder, and with the object of avoiding the necessity after that operation of a permanent ureteral fistula above the pubis. Tuffier's were *à propos* of M. Pousson's work on "Exstrophy of the Bladder." But they have a direct bearing upon the surgery of the kidney; and Harvey Reed's and Van Hook's experiments were directly in reference to the treatment of wounds and fistulæ of the ureters.

One out of three of Novaro's experiments upon the lower animals was successful. Bardenheuer's animal survived, but the operation was followed by stenosis of the ureteral orifice and hydronephrosis of the kidney of the same side. Gluck's and Zoller's, Tuffier's and Morestin's were unfavourable. These observers give warning of the liability of hydronephrosis from stricture as a result of the operation. Harvey Reed's were, in his own opinion, encouraging.

Harvey Reed made twelve experimental operations with reference to the implantation of the ureters into the rectum. Three were unilateral implantations and six double implantations of the ureters; in the other three operations either peritoneum or vasa deferentia were ingrafted in mistake for the ureters.

Two out of the three unilateral implantations, if not all three, according to Bacon's own view, "were successful in every respect"; but this is a much more favourable verdict than a careful study of his cases seems to me to warrant.

In one of these cases the kidney was not examined after the animal was killed; in a second there was nephritis with hydronephrosis; the third alone was entirely successful.

* *La Riforma Medica*, 1888.

† *Chicago Medical Recorder*, 1893.

"All of the six bilateral implantations terminated fatally." Reed therefrom concludes "that the unilateral implantation of the ureter into the rectum is a possible and practical surgical procedure"; and "that the simultaneous implantation of both ureters into the rectum is still a questionable surgical procedure, as shown by the experiments made thus far on the dog, and also by Küster's fatal case of double implantation of the ureters in man." He believes that bilateral implantation can be made successful by the introduction of one ureter at a time; giving the first time to recover before the second one is implanted.

Van Hook* experimented upon eight dogs, in each instance implanting a single ureter into the rectum after a special method of his own (*see post*, p. 603).

Three of the dogs died of general peritonitis, a not unlikely cause of primary mortality considering that (as Van Hook says) in order to avoid stricturing the ureteral orifice the sutures must not be applied too closely or too tightly about it. In each of these three dogs the kidney belonging to the implanted ureter was violently inflamed.

The five dogs which survived the operation were killed between the fourteenth and twenty-first day, and in three of them the kidneys corresponding to the implanted ureters were in a state of suppurative pyelitis.

In six experiments by Van Hook both ureters were implanted into the rectum. All the dogs died within six days—four from general peritonitis and two from nephritis, uncomplicated by peritonitis. The kidneys were infected in all the cases.

Van Hook, influenced by his own disastrous results and after a study of the whole subject, considers that the mechanical technique of the operation is not entirely free from septic infection of the peritoneum from the rectum, and that the kidneys and ureters are intolerant of implantation into the rectum; and he says; "The conclusion is inevitable, that intestinal or rectal implantation of the ureter is primarily and remotely an extremely dangerous procedure, unjustified by reason and condemned by experiment, and that inasmuch as the vital objections to this expedient are fundamental and not dependent upon criticism of a faulty technique, this operation must be regarded hereafter as unjustifiable in practice upon the human subject."

Harvey Reed, as previously stated, and Boari are on the other hand advocates of the rectal grafting of a single ureter. The former thinks it a safer procedure than nephrectomy; but this statement is not supported by figures; nor can it be, because there are not as yet sufficient cases of uretero-intestinal grafting on record to compare with nephrectomy; and we know that nephrectomy for fistula and hydro-nephrosis, much as it is desirable to avoid the operation for these conditions, is very successful.

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* *Journ. Amer. Med. Assoc.*, 1893, December 23rd, p. 970.

Van Hook's criticisms of Reed's experiments and conclusions are perhaps tinged somewhat too much with sarcasm, and his objections and arguments may be too strongly biassed against the procedure; still there is much force in the arguments he adduces.

Chaput tried many experiments upon dogs without success, but he points out that the difficulty in obtaining good results in dogs is owing to the small size of the ureter and the rigidity of the walls of the intestine causing the sutures to cut through. Such experiments, he thinks, are therefore not to be relied upon as a basis for conclusions as to the advisability of such operations on man. He is of opinion that the anastomosis of the ureters with the intestine is an easy and favourable operation and a valuable resource in certain cases where simpler methods are inapplicable; that it does not necessarily lead to hydro-nephrosis or pyelo-nephritis; that the bilateral operation can certainly be successfully performed upon man, and that the exit of urine into the intestine does not irritate the mucosa or cause any special inconvenience.

Grafting the ureter into the small intestine.—Implantations into other parts of the bowel (the ileum) have been tested in like manner with the colon and rectum by several experimenters, but the operations have been found liable to the same risks as the grafting into the large bowel, viz. the primary risk of peritonitis and suppurative uretero-pyelo-nephritis, and the later danger of stenosis at the point of implantation, with its consequences, hydro- and pyo-nephrosis.

Indications for uretero-intestinal grafting.—The cases in which uretero-intestinal grafting, if it could be relied upon, would be of invaluable service are the following:—

1. When—either by accident during abdominal operations, or designedly when involved in a new growth or in adhesions connected with ovarian or other tumours of the pelvis or abdomen—too much of the ureter has been re-sected to allow of grafting the ureter to the bladder.

2. In ectopia vesicæ so as to be able to do away with the imperfect bladder without being obliged to establish an external fistulous opening.

3. In certain cases of uretero-vaginal and other fistulæ where bladder grafting is impossible (Chaput's case), and as an alternative to nephrectomy.

4. To avoid ureteral fistulæ which would otherwise have to be established in cases in which part or the whole of the bladder is excised for tumour or tuberculous disease.

Technique of operations on animals.—The method of operating adopted by R. Harvey Reed* (of Mansfield, Ohio) in his experiments on dogs was the following:—"The rectum was opened about six inches above the anus on its lower aspect, in a line with its long axis, which opening was about half an inch in length. After controlling the hæmorrhage, the ureter was inserted into the rectum, and fastened there by a continuous silk suture, which included its peritoneal covering; and by the inversion of the edges of the rectal wound I was enabled to bring the serous membranes of the two edges of the bowel in close contact with the serous covering of the ureter, thus facilitating rapid adhesions. The remainder of the rectal wound was then carefully closed with a continuous suture."

Another method of Reed's was this:—"The incision in the rectum was only large enough to admit the ureter without constricting it. The rectal wound was closed with two aseptic silk sutures; the lower suture was taken after the manner of the Lembert stitch, which also included the flaps of the peritoneum on either side of the ureter, being careful at the same time not to include the ureter and to carefully invert the edges of the wound in the rectum, thus closing the rectal wound and fixing the ureter in the same, as well as bringing the serous surfaces in close contact with each other. The upper suture was taken in the same manner, with the exception that it was passed under the ureter instead of over it, as in the lower suture; thus leaving the lumen of the ureter free from mechanical stenosis." Aseptic silk was used to ligate the vesical portion of the ureter.

Dr. Reed's plan for drawing the ureter into the rectum was by means of a loop of silk over the end of the duct, and passing in a needle along the groove of a director and out through the rectal wall about one inch below the incision. By traction on the needle and silk the ureter was pulled through the incision in the rectum, so as to have from one-half to three-quarters of an inch of the ureter inserted in the gut. After closing the rectal wound, the loop was put on the stretch and cut off close to the peritoneal coat of the bowel, the elasticity of which allowed the loop to drop into the lumen of the rectum, and get swept off the ureter and carried out of the bowel with the fæces.

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* *Annals of Surgery*, vol. xvi., 1892, p. 197.

Van Hook's method, also employed experimentally on dogs, was the following :—"Raise an ample fold of peritoneum with the ureter. After severing the ureter, ligate the cystic end of the duct, and then split the opening of the renal portion of the tube with fine scissors upwards for a distance equal to three times its diameter. Cause two small needles, armed with a single fine silk or catgut thread, to pass from without through the split end of the ureter. The ureter is thus grasped in the loop. Now pass the two needles into the bowel through a small longitudinal slit on the free border, and carry them downwards about one-half inch. When they are now pushed out through the rectal walls the ends of the thread may be lightly tied together, drawing the ureter into position and permanently maintaining it there. The operation is completed by covering in the knot with two or more Lembert sutures, closing the rectal wound as well as possible without compressing the ureter, and applying a peritoneal graft."

Technique of operations on the human subject.— Sir John Simon established a free communication between the lower ends of both ureters and the rectum, by means of threads passed in needles worked within a cannula, so that a large part (but not all) the urine flowed into the bowel. His patient died of "an affection of the ureters and kidneys, with large calculous accumulations in the ureters."*

Sir T. Smith's† operation was upon a boy, aged seven. Having passed a small gum elastic catheter along the left ureter from the exstrophic bladder, he made a transverse incision in the left loin as for colotomy; the colon and kidney were exposed and the ureter was found and hooked up with an aneurysm needle and divided as low down as possible. The end of the ureter was stitched by means of fine catgut sutures to the back of the colon; a small opening was made in the colon; the end of the ureter was pushed into the bowel, into the cavity of which it protruded about half an inch. It was kept in position by additional sutures of very fine carbolised catgut passed through the lips of the wound in the colon and through the cellular tissue surrounding the ureter. For six days the course of the case was favourable, then the wound in the loin opened and urine and fæces passed through it and continued to do so for eight months. In the second operation fine silver wire sutures were used.

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* *Lancet*, vol. ii., 1852, p. 567; Holmes, "Surgical Treatment of Children's Diseases," p. 147.

† *St. Bart. Hospital Reports*, 1879.

Chaput's operation for fistula.—The ascending and descending colon are in his opinion, the points of election. His parietal incision commences above at the border of the costal cartilages about three inches or a little more from the median line, and extends to the level of the anterior superior spine of the ilium and then curves to within a little less than two inches from the middle line. The peritoneum is opened, the colon and coils of small intestine are pushed aside and held beneath a compress by an assistant. The posterior parietal layer of peritoneum is then incised for a distance of 10 cm. in the iliac region, parallel with the insertion

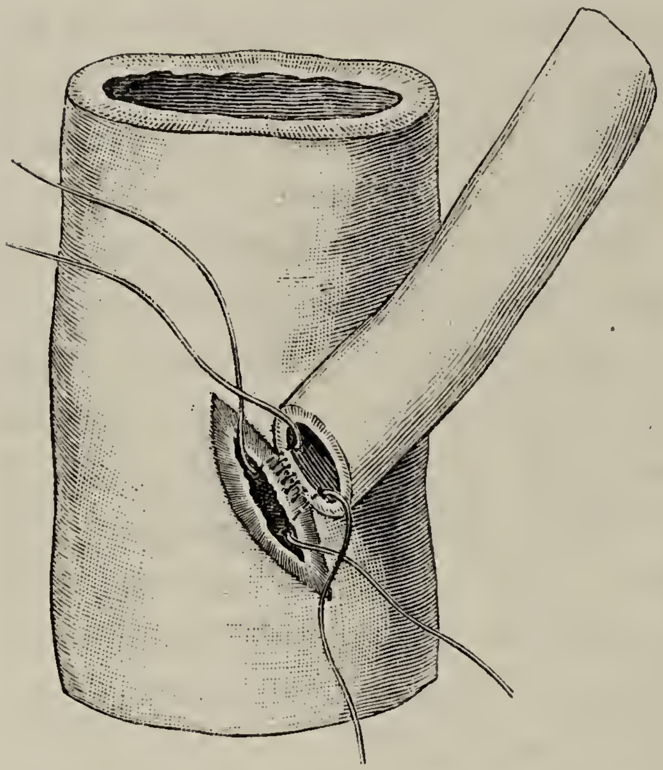

Fig. 194. — Implantation of Ureter into Intestine: Chaput's Method. Sutures through the mucous coats (long ends) of the posterior lips. The ureter is previously attached to the opening in the intestine by rows of sutures through the serous and muscular coats.

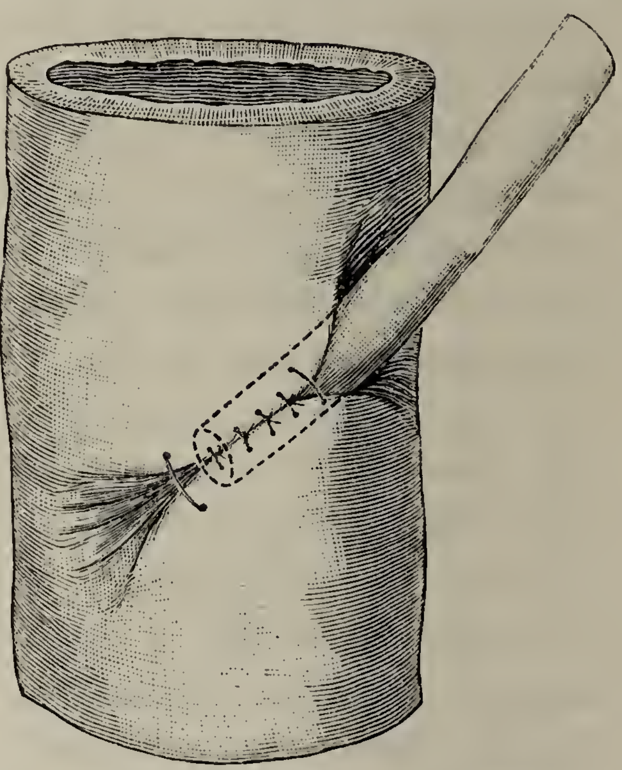

Fig. 195.—Implantation of Ureter into Intestine: Chaput's Method. Method adopted if the ureter is too small in diameter and too delicate to carry the two rows of sutures. The ureter is then buried in a fold of intestine by the rows of sero-serous sutures.

of the meso-colon. The internal edge of the posterior peritoneal incision is seized with forceps, and the peritoneum is stripped up as far as the vertebral column. The ureter is sought for and divided between two pairs of forceps, the inferior end is at once tied and replaced, and the superior end is sutured to the postero-internal aspect of the colon.

Chaput's mode of fastening the ureter to the gut is as follows:—He first attaches the posterior lip of the ureteral orifice by three or four sutures to the bowel before incising the latter. These sutures unite the serous layer of the two structures and do not penetrate to the mucous membranes. The intestine is then incised in a direction corresponding to the ureteral orifice to the extent of 1 cm., and several millimetres below the preceding row of sutures. The mucous membrane of the posterior lip of the ureteral orifice is sutured to the mucous membrane of the bowel, and then the anterior lip of the ureteral orifice and the opposite margin of the gut are sutured by means of their serous and muscular coats. The rest of the intestinal incision is closed by a few sutures, and the extremity of the ureter for a distance of about 2 cm. is buried in the intestinal wall by two rows of sero-serous sutures. Chaput used a gauze drain placed over the situation of the graft.

In Chaput's original paper* there is a good *résumé* of the work done by experiments on animals, and by operations on the human subject, in the way of grafting the ureter into the rectum and colon; to this the reader interested in this important subject is referred.

Maydl's successful method of excising from the bladder wall its trigone, together with both ureters, and implanting them into the sigmoid, has been already referred to.

Carl Beck of Chicago,† in a case of tuberculous disease of the bladder for which cystotomy and curetting of the bladder had done no good, cut off the ureters about an inch behind the bladder and grafted them into the sigmoid flexure in the following manner:—A flap was made in the gut consisting of peritoneum and subperitoneal and muscular tissue, leaving only the mucous and submucous tissues untouched. The ureters were carried beneath this flap and their ends made to project through a small opening in the mucous lining of the bowel so that one inch and a half of each was hanging free in the lumen of the gut. The ureters were inserted one

* *Archives Générales de Médecine*, Jan., 1894, 8th series.

† *Chicago Med. Recorder*, Nov., 1899.

above the other; while the flap held them in a sort of groove in the bowel wall, and the peritoneum below was sutured for a short distance. The result was excellent (Bransford Lewis).

THE OBJECTIONS TO GRAFTING INTO BOWEL.

The small intestine is too movable and there is a chance of strangulation of the ureter or of the bowel, as well as of intestinal colic and various reflex disturbances. The rectum is too far off when the ureter is cut near the kidney. Every form of uretero-intestinal grafting exposes the patient to the risks of peritonitis, renal suppuration, and nephrectasis from stenosis of the artificial ureteral opening.

Hydro-nephrosis due to stenosis at the site of the implantation is likely to arise when the ureter is grafted into any part of the bowel, because of the constant action of the intestinal muscular coat, which is "urged into activity by the presence of the ureter" and urine. Chaput's patient did not suffer in this way, however, nor did the patients who were operated upon after Maydl's method.

Infection through the ever-present bacillus coli communis and other micro-organisms getting into the ureter from the bowel, and setting up septic pyelo-nephritis, is, however, equally with *infective peritonitis*, one of the most pregnant causes of failure.

The operations which succeed in turning the ureteral orifice back into the bladder, and thereby restore the normal physiological condition are, beyond all doubt, vastly superior to grafting the ureter into the rectum or colon. If intestinal grafting is employed the sigmoid flexure or some part of the colon should be preferred to the rectum: (1) Because its contents are not so stationary and the colon is less a reservoir for fæces and foul gases than the rectum; and (2) the urine can accumulate for a longer time without leading to the necessity of frequent relief of the bowel.

Bransford Lewis * has given a brief summary of seventeen cases of exstrophy of the bladder operated upon by Maydl's method in the preceding five years. Only two deaths were recorded as attributable to the operation, one from shock and the other from infection after a period of four months. Urinary continence was perfect in all the cases excepting two. "The patients were able to hold their urine for at least three hours, sometimes for six or seven hours, and in one case throughout the night. The urine was voided sometimes mixed with fæcal matter, sometimes alone. The tolerance of the rectal mucous membrane was perfect."

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* *Annals of Surgery*, June, 1900.

CASES OF IMPLANTATION OF THE URETER INTO THE BOWEL.

Date.	Name.	Method, &c.	Result.	Why performed.
1855, July.	Simon: "Surgical Treatment of Children's Diseases," Holmes, p. 147; *Lancet*, vol. ii., 1852, p. 567; *Path. Soc., Trans.*, vol. vi., p. 256.	Loop of thread, passed by means of needles worked within a cannula, made to ulcerate through contiguous portions of ureter and rectum. Communication resulted. Urine escaped by the anus after the 10th day, phosphatic concretions formed in the lower ends of uterus, and the boy's condition, though oscillating, was more or less serious throughout.	Death one year after operation. Suppurating pyelitis on both sides.	For exstrophy of the bladder.
1878	T. Smith: *St. Bartholomew's Hospital Reports*, 1879, vol. xv., p. 29.	Each ureter inserted into the back of the colon on the corresponding side. Operation on the second ureter 14 months after operation on the first; fatal in 24 hours.	Necropsy.—Left kidney, the first one submitted to operation: hydro-nephrotic from stenosis—a probe passed along the ureter would not enter the bowel. Right kidney: obstruction to the passage of urine at junction with bowel. Ureteritis and acute septic pyelo-nephritis on the right side.	For exstrophy of the bladder.
1891	Küster: Langenbeck's *Archiv.* 1891.	Both ureters into the rectum, after complete cystectomy for cancer. The mucous membranes were sutured together with fine catgut and on the peritoneal aspect the ureter and rectum were fastened with silk sutures.	Death; purulent peritonitis; sutures did not hold; renal infection but ureters were not dilated.	Cystectomy for cancer.
1892, Sept.	Chaput: *Archives Générales de Méd.* 1894, vol. i., p. 11.	Ureter dilated; junction made with postero-internal surface of the colon on the left side.	Successful; drain in posterior peritoneal space. 12 months after there was no sign of infection.	For uretero-vaginal fistula following operation for vaginal hysterectomy.
1892, Nov. 1893. March.	Chaput: *Archives Générales de Méd.*, 1894, vol. i., pp. 23 and 24.	The first, the left ureter, was successfully implanted into the sigmoid flexure; the right ureter was implanted into the cæcum three months later.	First operation successful. Death occurred the same day after the second operation. The patient became comatose; there was suppression of urine, the watery motions ceasing. No necropsy.	For tuberculous cystitis and vesical fistula following operation.
	Leet.	Operation performed for relief of severe tuberculous cystitis.	Successful.	

By means of Maydl's method, Fowler, Carl Beck, Dudley P. Allen, Nové-Josserand, E. Herczel, and several other surgeons have had successes by grafting the bladder tissue or the two ureters with the sigmoid flexure or the rectum.

CHAPTER XVIII.

PLASTIC OPERATIONS ON THE URETER

(Continued).

OPERATIONS FOR RESTORING THE COURSE OF THE URINE TO THE BLADDER BY MEANS OF SOME FORM OF "SPLICE" OR SUBSTITUTE FOR A DEFICIENCY IN THE URETER.

IMMEDIATE implantation into the bladder is feasible only in cases of uretero-vaginal fistula and for injury to the ureter when the injury, whether the result of accidental or surgical wound, is at or very near the vesical end; and when the conditions as to asepsis and powers of endurance of the patient are favourable. The success of this treatment, as previously shown, is amply sufficient to justify and recommend it.

In cases of loss of substance too great to permit of uretero-ureteral anastomosis or vesical grafting, various plans have been devised by means of which the urine is still made to find its way to the bladder; and the loss in substance of the ureter has been made good by forming a new channel connecting the two ends of the ureter, or the ureter with the bladder, out of some other tissue, such as skin, peritoneum, cellular tissue, bladder, or bowel.

These operations at present offer little or no promise of practical surgical success, but they will be briefly described here as it is of interest and importance, historically, to know what measures have been tried to obviate nephrectomy and at the same time to prevent the formation of fistula.

The practical objections to them all are that the distal extremity of the ureter shrinks and becomes useless, and that none of the substitution tissues, except the bladder diverticulum, forms a good channel for urine.

Substitution by connective tissue: *Nussbaum's method.*—Nussbaum, who had in 1882 joined the divided ends of the ureter of a man by a similar procedure, substituted a connective-tissue tube for part of the ureter.*

* *Otto conferenze di Clinica Chirurgica, Trad. Ital.*, 1882, and *El Siglo Medico*, 1887, 434.

"In a case of fistula opening upon the abdominal wall after a laparotomy, Nussbaum passed a suitably shaped glass tube into the bladder from the abdominal wound through the intervening connective tissue. After the tube had remained in position for some time, it was withdrawn, and the haphazard procedure was followed by success" (Van Hook). There is no information as to the ultimate and permanent result.

The objections to this kind of connective-tissue "splice" are: (1) the almost certain contraction which must follow; (2) the impossibility of such a tube becoming lined by epithelial cells, since the epithelium of the ureter and bladder could not proliferate over such an extensive surface; and (3) the liability of infection of the connective tissue and of consequent ascending uretero-pyelo-nephritis.

Substitution by skin.—Instead of a splicing of connective tissue such as was made by Nussbaum, Rydygier* proposes to construct one out of the skin of the abdominal wall—one by which the lost portion of ureter is made good by an artificial channel of epithelium-covered tissue.

He recommends that in cases of injury to the ureter during surgical operations, its two ends should be brought out through the abdominal wall. After the abdominal wound is healed, a tube is made between the two ureteral openings by dissecting up the skin by means of two parallel incisions, one on each side of the ureteral orifices, and suturing together the detached edges. This tube is then depressed and covered over by drawing from each side and sewing together the other cut margins of the abdominal skin wound.

Substitution by a diverticulum of the bladder.—Van Hook has suggested the following very ingenious plan for replacing a lost portion of the ureter by means of a vesical diverticulum, when the duct cannot be implanted directly into the bladder:—

1. Implant the ureter upon the skin of the abdomen in the median line, as near the bladder as possible. Close the abdominal walls as usual except for the presence of the ureter.

2. When the patient has fully recovered from the primary operation, open the structures composing the abdominal wall between the ureter and the pubes down to the peritoneum and bladder. The peritoneum must not be opened. The bladder may be distended exactly as in supra-pubic cystotomy.

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* Uretero-plasty, *Centr. für Med. Wissen.*, Oester-Ungar, 1892.

3. Make two incisions in the bladder parallel to the median line, beginning as near as possible to the peritoneum without prejudice to its integrity, carry them down at a distance of about 15 mm. apart towards the neck of the bladder under guidance of the finger. With scissors curved on the flat, the two incisions are now united at the lowest point, and hæmorrhage is controlled with pressure forceps. We now have at our disposal a vesical flap of considerable extent hinged above by a nutrient pedicle.

4. The ureter is loosened from the skin, and brought well down towards the flap, which is simultaneously raised to meet it. The vesical flap is firmly fastened back in its new position by catgut sutures passing through the neighbouring muscles or fascia, and the end of the ureter is held in position by light catgut sutures which pass through the loose peri-ureteral connective tissue, if possible, and through the muscular structures near at hand.

5. The edges of the vesical flap are now sewn together to form a tube, into the upper end of which the ureter is introduced. A similar row of light catgut sutures close the bladder wound itself. The lower angle of the vesical opening is best left open for the sake of drainage. The upper part of the skin wound together with the fasciæ may be closed.

The bladder can be thus plastically extended to meet the ureter without opening the peritoneum, when the ureter is brought out upon the abdomen at any point more than 8 cm. (about 3¼ inches) below the umbilicus.

The bladder flap can be made considerably longer, indeed long enough to meet the ureter at any point one inch or more below the navel, if the peritoneum is opened transversely at or very near its vesical reflection and sutured to the back of the bladder as low down as possible. The remaining steps of the operation after the peritoneum has been thus transplanted to the base of the bladder are the same as those which are mentioned above, and if the urine is aseptic, they should be performed at once.

Van Hook has only practised his method upon the cadaver, but he speaks of it as being as practicable and easy as the majority of operations daily undertaken.

He adds that the harmlessness of symphyseotomy when carefully performed would render it justifiable as a preliminary step in this operation to make a vesical diverticulum to meet a shortened ureter; but it is difficult to see either the necessity or the justifiability of thus further complicating a necessarily tedious and severe procedure.

Boari has also described and figured a similar plan for making good a short length of the lower end of the ureter by dissecting an elongated flap from the anterior wall of the bladder. The bladder wall and the flap are then sutured in such manner as to make a tube out of the flap, and into the upper end of this vesical tube the lower end of the ureter is grafted.*

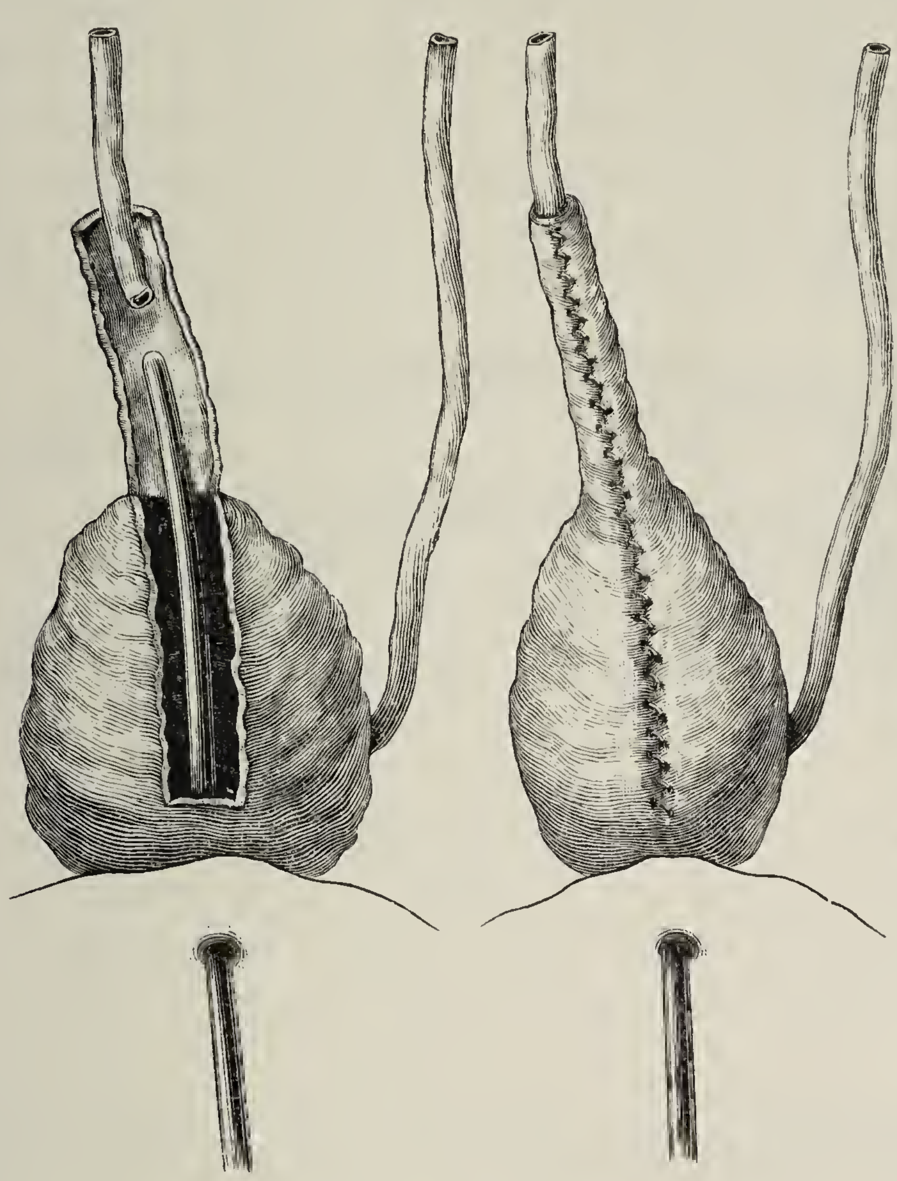

Fig. 196.—Technique of the Operation by the Plastic Method for the Inferior Third of the Ureter. (Boari and Casati.)

Substitution by a decalcified bone tube.—Van Hook describes an experiment on a calf in which the lower end of the upper portion of the ureter was sutured into one end of a thoroughly decalcified turkey's wing-bone, the other end of the bone tube being sutured into the bladder. All went well with the calf for fourteen days, but on the sixteenth it died from adhesive general peritonitis.

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* See *Ann. des Mal. des Org. gén.-urin.*, Nov., 1896, p. 1168.

The kidneys were found normal, the bone tube was unchanged and retained its connections with both ureter and bladder, and a perfect tube of connective tissue had formed around the bone. At the point where the ureter entered the bone tube, there was an opening communicating with a large retro-peritoneal sac, containing a gallon of urine. This sac was the result of back flow, due to intra-vesical pressure, and it shows the importance of removing this pressure by means of the catheter in all cases in which the ureter is implanted directly into the bladder and the valve action of the normal cystic opening of the duct no longer exists, as well as in attempts to replace the ureter by a connective tissue or skin tube.

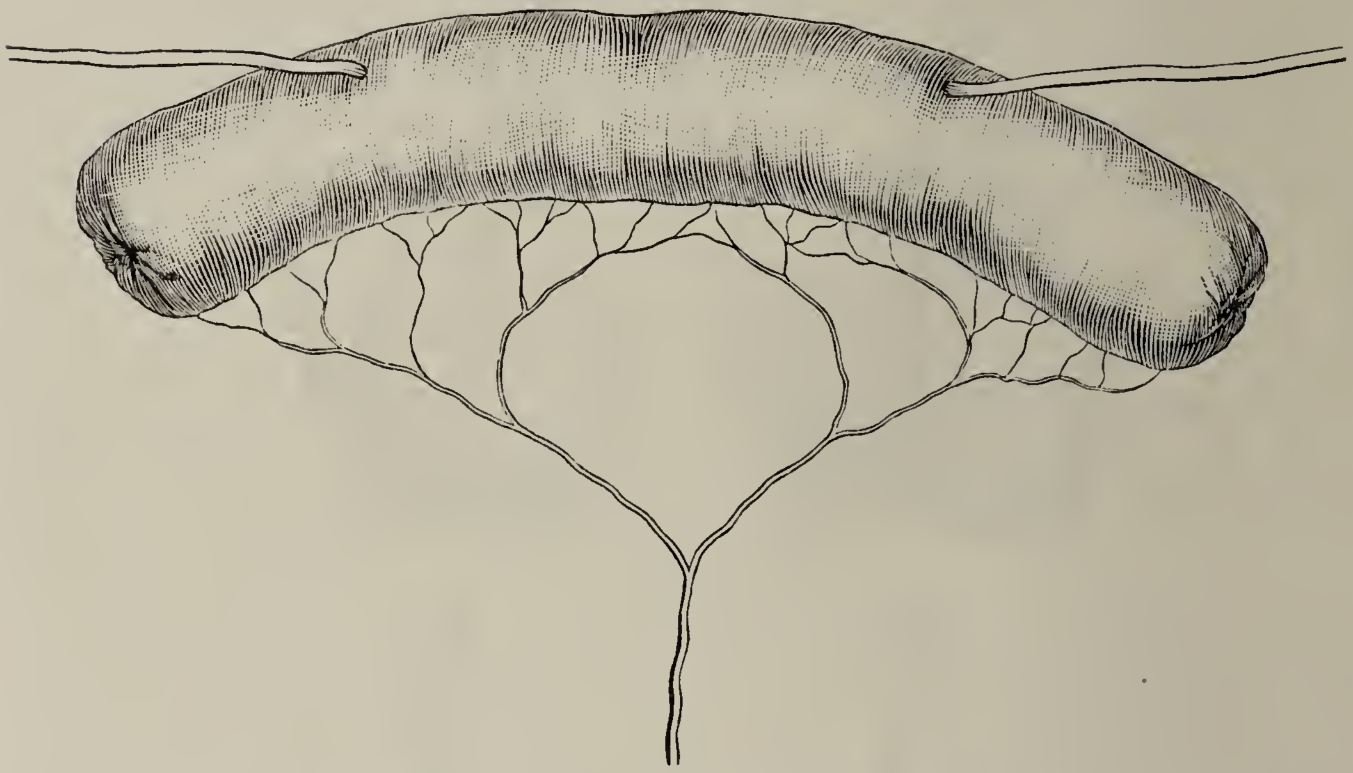

Fig. 197.—Transplanted piece of Gut, with its ends invaginated, and the cut ends of the Ureters planted into the Gut: Dr. J. B. Bacon's Method.

Substitution by an isolated piece of bowel.—Joseph B. Bacon* of Chicago made the suggestion of replacing ureteral losses by splicing the ureter with a portion of small intestine isolated in such a manner as to leave the transplanted loop of bowel well supplied with blood vessels, the continuity of the intestines being restored by Murphy's button. The ends of the injured ureter are engrafted into the transplanted portion of bowel, the extremities of which have been invaginated and sutured with purse-string sutures.

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* *Chicago Medical Recorder*, April, 1893, p. 278.

The urine thus will pass by a continuous channel from the renal pelvis to the bladder through this splicing of gut.

Bacon suggests placing the piece of isolated bowel where the ureter was, and scarifying its surface and putting in a few stitches to retain it in position. There will be an exudation thrown out which will bind it down, so that no hernia can get under it. The ureter is to be sewn into this piece of gut with Lembert sutures, catching only the walls of the ureter without perforating its canal. The cut end of the duct should be split to widen it, then drawn into the incision in the bowel, and the junction should be covered by peritoneum. Christian Fenger* also proposed to substitute for a segment of the ureter a sequest rated loop small intestine.

D'Urso and Fabii of Rome have in their recent experiments substituted a portion of small intestine for almost the entire length of the ureter. They have also employed the horn of the uterus as a substitute for part of the ureter in the dog; and they suggest the Fallopian tube as a substitute in woman. They go minutely into the technique which they employed, and which these operations necessitate, and their text is illustrated by some very clear diagrams.†

The objection to this method is (1) the bowel is septic; (2) the patient is exposed to all the risks of an operation for re-section of bowel in addition to those of the original operation during which the ureter is injured and by which the endurance of the patient has been tried probably to its utmost limit.

Van Hook proposes what he thinks would be a less dangerous method than that of Bacon's, namely, to bring the isolated loop of bowel out of the peritoneal cavity and embed it with adequate drainage between the peritoneum and skin; at the same time to make a ureteral fistula above the isolated bowel, and attach the upper end of the lower part of the ureter to the tissues below it. The gut will shrink and become less septic, and should afterwards be connected with the ends of the ureter by a second operation.

These proposals have never hitherto been put into practice in the human subject, so far as I am aware.

It is more than improbable, in my opinion, that either the original suggestion or the proposed alternative will ever obtain favour with surgeons; nor is it to be expected that the condition of the patient, under the circumstances in which it is at all likely to be called for, would be such as to justify a trial of this procedure.

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* "Surgery of the Ureter," *Annals of Surgery*, vol. xx., July–Dec., 1894.

† *Annales des Maladies des Organes génito-urinaires*, Nov., 1900.

The patient would be most unlikely to be equal to all the risks of an operation for re-section of the bowel, in addition to those of the original operation during which the ureter was injured.

CHAPTER XIX.

URETEROTOMY AND PYELOTOMY.

By ureterotomy is meant the longitudinal division of some part of the ureter, and by pyelotomy an incision into the renal infundibulum, for the purpose (1) of testing the patency of the ureter; (2) exploring for calculus; or (3) removing an obstruction either from within their lumina, or in the substance of their walls, with the object of the re-establishment of a good channel for the urine from the kidney or the bladder. It may therefore, as a *specific operation,* be required (1) to extract an impacted calculus, or (2) to divide a band, stricture, valve, or cicatrix. As an *exploratory or diagnostic operation* the incision of the ureter is followed immediately by the passage of a ureteral sound or bougie to test the patency of or to ascertain the precise situation of an obstruction in the duct. It has been proposed and practised in four cases by Howard Kelly* to ascertain if the ureter had been included in a mass of ligatured tissue during the course of abdominal operations. Pyelotomy or ureterotomy should be employed in every case in which the kidney is explored, unless the ureteral sound can be passed along the ureter from the wound in the convex border of the kidney substance. Plastic operations for the closure of accidental wounds, and "re-section" or the excision of a length of the duct and the rejoining of the divided ends, are not included under these terms. Pyelotomy may best be considered together with ureterotomy as it is employed for the same purposes; often the incision for stricture or a plastic operation extends into both ureter and renal pelvis, and then the operation is named pyelo-ureterotomy. Ureterotomy may be practised upon any part of the ureter, and has been performed through the bladder, the vagina, the rectum, and the abdomen across the peritoneal cavity, as well as by various routes through the abdominal and pelvic walls without opening the peritoneum (*see* Chapter XII.).

Choice of method—When any part of the abdominal section, or the first part of the pelvic section of the ureter, either in the male or female, is to be the seat of the operation, the retro-peritoneal method along the course of the lumbo-ilio-inguinal line, indicated in the diagram, on p. 132 (Vol. II.) is the line of election for cutting down upon the ureter. In the male the whole of the pelvic section of the ureter, quite down to the bladder, can be reached without opening the peritoneum, through the incision of the abdominal parietes along the lower or anterior half of this line. This however is not always the case in the female, in whom the sacral or vaginal route is to be preferred (*see* p. 525, Vol. II.).

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* "Operative Gynæcology," vol. i., p. 465.

The *vesical* and *rectal* routes have been employed in exceptional cases of uretero-lithotomy for calculi impacted at the extreme lower end of the ureter.

The *trans-peritoneal* or *intra-peritoneal* ureterotomy is to be condemned, excepting, possibly, when done for exploratory or diagnostic purposes in the course of abdominal operations to test the patency of the tube. Even then it is not to be adopted unless the operator is absolutely sure of the aseptic state of the urine, a confidence he is often far from being justified in feeling.

The advantages which have been claimed for the trans-peritoneal route for the purpose of merely examining the ureter are—

1. The slight gravity of laparotomy.
2. Greater certainty and rapidity of operation.
3. Minimum amount of injury to parts.

Nos. 2 and 3 are very doubtful; in most cases I believe No. 2 is wrong as regards the discovery of the ureter itself.

But for the performance of ureterotomy the trans-peritoneal operation must be reserved for cases in which the contents of the ureter are believed to be aseptic and the ureteral wound can be perfectly closed; thus it is inapplicable for extraction of impacted calculus, and for division of strictures or valve formations, though suitable for certain cases of grafting the ureter into the bladder or bowel. I am, as has already appeared, an opponent of abdominal nephrectomy except for tumours under certain conditions: the lumbar operation as a general rule is and always has been in my opinion the proper one. But the objections I entertain to the peritoneal route for operations upon the ureter are if possible still more decided. Even the mere exploration of the ureter by the trans-peritoneal method should be avoided when there is any indication as to which ureter and what part of it is concerned; for, in spite of the exemption from serious risk which the aseptic and antiseptic precautions afford, the shock caused by a free handling of the abdominal viscera is sometimes considerable, and ought not to be disregarded. In reference to this subject I will quote the words of two recent French writers, which give a fair idea of the views of the majority of French surgeons of the greatest experience in this branch of surgery. They express my own opinion pretty exactly. Dr. Jean Liaudet* says of trans-peritoneal ureterectomy, "It is to be forbidden completely"; and of trans-peritoneal nephrectomy he adds, "It is judged to be bad and a thing to be abandoned"; and he sums up his remarks by saying that, in cases in which the surgeon has no alternative but the trans-peritoneal method of ureterectomy, the best thing is to abstain altogether from the operation. Glantenay† remarks that the peritoneal method offers less certainty of discerning the ureter, and less security against risks, and on this account it ought not to be adopted for ureterotomy, especially if the ureter is much altered, or very adherent, or filled with pus. He adds, "It is then no longer a question of surgical preference which should regulate the choice of the operator, as the extra-peritoneal method is clearly obligatory."

INTRA-PERITONEAL URETEROTOMY.

If intra-peritoneal ureterotomy is performed in the course of an abdominal operation for a pelvic tumour or for some other purpose (and under no other circumstances should it be done), the peritoneum should be divided to the extent of 1½ or 2 inches parallel with the ureter, but a little to the outer side of it, not immediately over it; the peritoneum should then be dissected up, and the ureter exposed and incised longitudinally and only to the extent requisite to accomplish the purpose in view. This incision in the ureter should be made as far towards the posterior aspect of the duct as possible, so that the peritoneum when replaced may not be resting immediately upon it. The ureteral wound should be closed by fine silk sutures passed transversely through the outer and middle coats of the duct, after the manner of Lembert, if the duct is large and thick enough to permit of them; the divided areolar tissue, which sometimes forms a thick sheath for the ureter, should be drawn together and stitched over the

* "De L'Urétérectomie Partiale et Totale," pp. 113 and 114 (1894).

† "Chirurgie de L'Urétère," p. 54 (1895).

duct; and finally, the peritoneum should be placed back in position and secured by one or two fine silk sutures. No compress or packing of iodoform gauze or other material should be employed, but the abdominal cavity should be completely closed unless a drain-tube is introduced for reasons connected with the condition for which the cœliotomy was undertaken. The best place to seek for and open the ureter from within the abdomen is at the pelvic brim, where the termination of the common iliac artery is a good guide to the duct.

EXTRA-PERITONEAL URETEROTOMY.

Three routes to the ureter for the purpose of ureterotomy may be taken:—(1) the lumbo-ilio-inguinal line, or some part of it, (2) the sacral, and (3) the vaginal. A fourth, the perinæal, is of very limited application for certain cases of impacted calculi.

1. **The lumbo-ilio-inguinal.**—When the operation is commenced as an exploration of the kidney and ureter, the usual oblique incision in the ilio-costal space will be made, and should subsequently be continued as required further and further forwards and downwards—passing the anterior superior iliac spine an inch to its anterior or inner side—towards the middle of Poupart's ligament, and then onwards parallel with and an inch above it, nearly as far as the external abdominal ring.

When, either by the clinical symptoms, by palpation of the abdomen, or by rectal or vaginal palpation, or by a previous exploratory cœliotomy, it is known that the ureterotomy is to concern the pelvic section of the duct, the incision of the parietes should still be in the same line as the above, but need not extend nearly so far backwards and upwards. It should be commenced on a level with the anterior superior spine of the ilium an inch to its front and inner side, and be prolonged downwards, forwards, and inwards to the extent requisite to bring the ureter well in view. When the peritoneum has been reached it should be carefully detached with the fingers and by a few touches of the scalpel, and gently dragged towards the median line and held by an assistant. A flat sponge should separate the fingers of the assistant from immediate contact with the detached peritoneum. It must be remembered that the ureter, firmly adherent as it is to the outer face of the peritoneum, especially in its abdominal section, will be detached with, and must be sought for on the raised peritoneum; and neither the assistant's fingers nor the sponge must be placed so far over the detached peritoneum as to impede the search for the tube.

2. **The sacral route** may be employed in either sex when the lower part of the pelvic section of the ureter is concerned. It would be easier in the male than the female pelvis, on account of the increased difficulty caused by the broad ligament and the number and direction of the vessels of the ovary and uterus. I have successfully adopted it twice in the living female, once for the removal of a single calculus, and once to remove the ureter containing a number of calculi. The best plan of reaching the outer surface of the peritoneum on which the ureter will be found is that of Delbet and of the author (*see* Chapter XIV., p. 525 *et seq.*, Vol. II.).

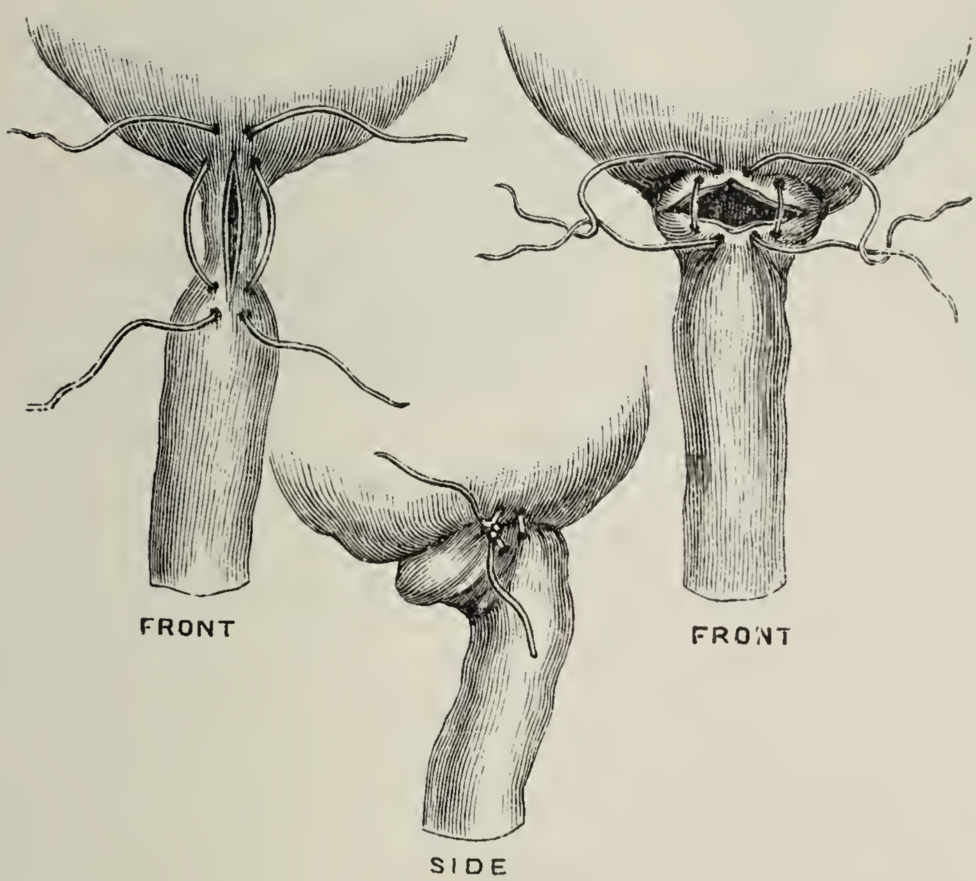

Fig. 198.—To illustrate the mode of applying the sutures after division of a stricture or a valve. In the side view figure the pucker caused by tightening the sutures is somewhat exaggerated. (From the same case as Fig. 199.)

3. **The vaginal route** for exposing the juxta-uterine and juxta-vesical part of the ureter is best carried out by Doyen's method (*see* Chapter XIV., p. 529, Vol. II.). Venous hæmorrhage is likely to be troublesome in this operation on account of the free plexus which surrounds the ureter here.

The division of the ureter.—When the ureter has been exposed, no matter by which of these routes, it should be incised longitudinally on its posterior wall to the extent demanded by the condition for which the ureterotomy is being done.

The ureter at the point of operation should be sufficiently detached from its connections to be conveniently accessible for the necessary manipulations. This separation should be made carefully so as to avoid injuring the peritoneum, or the spermatic or other vessels in relation to the part of the ureter which is being freed; nor should it be detached to any unnecessary extent. It is not always requisite to so far detach it as to be able to bring it right out of the wound, as has sometimes been recommended, nor to reflect its cellular tissue investment from it for more than one half the circumference of the ureter. The wound should be protected from contact with pus or urine by packing some small pieces of sponge or iodoform gauze about the ureter at the point to be opened. If the ureterotomy is being done to extract a calculus, the incision should not be made directly over the calculus if it is possible to move the stone upwards to a point where the ureter is probably dilated, and where its walls have not been damaged by prolonged direct pressure by the calculus. The wound in the dilated ureter or renal pelvis should be closed by sutures, but the precise manner of passing them will depend upon the purpose for which ureterotomy or pyelo-ureterotomy is performed. When the ureter is not dilated, and especially if it has very thin walls and a small lumen, sutures should not be employed, because then there is fear that a stricture or contraction may follow the process of repair. After uretero-lithotomy, and also when ureterotomy is undertaken with a diagnostic object, the sutures should be passed transversely to the line of incision. Three or four sutures should be used for an incision from three-quarters of an inch to an inch in length. When operating for stricture the cicatricial or stenosed tissues must be cut completely through. Whether this is done by making the incision from above downwards or from below upwards is a matter of convenience. The sutures should be passed in the longitudinal direction, and the upper and lower ends of the longitudinal wound brought together. The line of incision will thus be changed into a transverse direction (Fig. 198). The sutures should not in any case be allowed to penetrate the mucous membrane, if the walls of the duct are thick enough to carry them without their doing so. In operating for stricture or valve formation it will in most instances be necessary to make a separate small opening, either into the renal pelvis or into the ureter, for the purpose of passing a probe or a bougie through the stenosed part (*see* Fig. 199) upon which to divide the stricture.

Fenger,* speaking of ureterotomy near the kidney (pyeloureterotomy) for the division of valvular obstruction, says: "The operation for valve formation can best be done by the extraperitoneal lumbar incision." The dilated pelvis or hydro-nephrotic sac is easily found and opened by a longitudinal incision. The opening of the ureter into the sac should be looked for, but cannot always be found, as in some cases it is very narrow. In such cases it may be treated by incising the ureter below the sac, and passing a probe upwards towards the pelvis. The valve or inner wall of the ureter running in the sac is now divided longitudinally from the opening in the sac, and the resultant wound treated in one of the three following ways:—

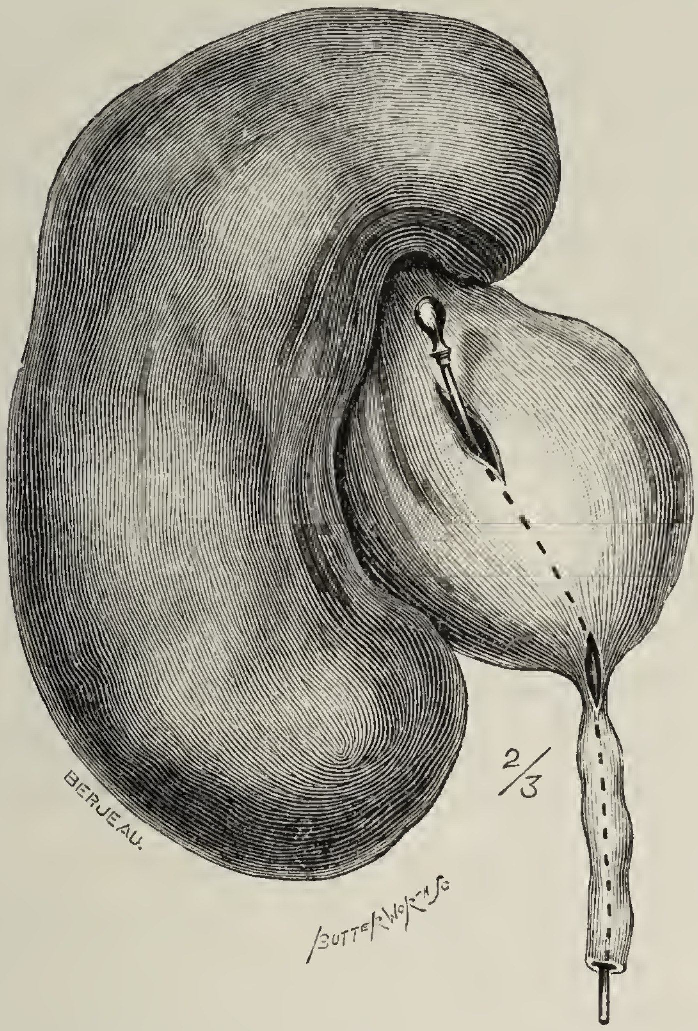

Fig. 199.—Pelvis of the Kidney and upper end of Ureter, showing the Stricture at their junction. A probe has been passed along the ureter through an opening in the infundibulum. (Author's case, from the same case as Fig. 198, "Hunt. Lect.," Table vi., No. 19.)

1. By turning the flaps out and uniting them to the inner wall of the sac by sutures (Trendelenburg, Küster);
2. By drawing the corners of the longitudinal incision together

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* *Annals of Surgery*, 1894, p. 271.

with one suture, transforming the longitudinal into a transverse wound, as in my operation; or

3. By uniting the wound longitudinally with numerous fine silk sutures, "taking in the two outer coats of the ureter and sac, and avoiding the mucous membrane" (Mynter).

Question of sutures.—Though there is no doubt as to the necessity of sutures in intra-peritoneal ureterotomy, opinions differ widely as to their use in the extra-peritoneal operations.

Le Dentu thinks they are requisite for success, save in the cases where the wound is near the renal infundibulum. Tuffier employed them in his experiments, and recommends them in operations on man. Bardenheuer and Twynam used sutures in their extra-peritoneal operations. In Twynam's case leakage of urine and some suppuration followed, but a cure finally resulted. Doyen also used sutures after removing a calculus by the vaginal route. On the other hand, Van Hook is of opinion that they are unnecessary, as these wounds, he says, unite rapidly if left to heal by granulation. Cabot goes further, and considers sutures actually harmful, because, owing to the thinness of the walls of the ureter, it is very difficult to prevent the sutures from penetrating the lumen of the canal and there acting as nuclei for the formation of fresh calculi.

Whilst admitting that sutures are not essential if drainage as a precaution in case of leakage is provided for; and though I know from experience that longitudinal wounds of the ureter heal well without them, I yet recommend and employ them in all cases on the renal pelvis, and on the ureter itself if dilated, or even if not dilated, provided the lumen is of good diameter and the ureteral wall of fair substance—but not otherwise. Unless the edges of the wound have been much contused, or the urine is very septic, sutures well applied hasten the healing and prevent the escape of urine and the formation of a fistula. I am in the habit of incising the renal pelvis for the extraction of calculi whenever they present at or are readily reached through its walls; and I always close the opening by one or more sutures, no matter what the condition of the urine, with the result that, as a rule, no urine escapes through the lumbar wound. The walls of the renal infundibulum are usually and those of the ureter are often thick enough to hold very fine silk sutures passed in a small round needle without their penetrating the mucous membrane; and even if the sutures are not entirely outside the mucous membrane I do not think it much matters if Lembert's method is adopted. The dread of their becoming the nuclei of calculi has been often expressed; but so far as I have found at present, it has no more foundation in fact than the former similar scare about sutures passed into the renal parenchyma. Ample experience has shown that sutures remain in the kidney substance for months and years without having any salts deposited upon them. It is certainly much better to make the effort to secure the direct passage of urine to the bladder by fastening the edges of the wound together, than to leave the wound free for the escape of septic urine into the cellular tissue space. If extravasation is mechanically prevented by the sutures for a few days, time is given for the primary union of the tissues around; and this accomplished, there is additional security afforded by the cicatricial material against extravasation later on.

The parietal wound should be carefully brought together by deep sutures; and as a security against the ill effects of extravasation of urine a small drain-tube should be kept in for two or three days.

CHAPTER XX.

URETERECTOMY.

History of the operation.—By ureterectomy is meant the partial or complete ablation of the ureter. It is an operation of quite recent date. The rapid development of ureteral surgery during the last few years had been gradually leading up to it.

At the congress of surgeons held in Berlin in 1892, Küster of Marburg related a case in which, in July, 1891, he re-sected a portion of the ureter to remedy a very tight stricture near the renal pelvis (*see* p. 557, Vol. II.).

At the same congress Reichel of Würtzburg related a case in which he had re-sected a cystic swelling situated behind the sac of an inguinal hernia in a boy nine and a half years of age. The cyst was regarded as an isolated diverticulum of the hernial sac, and was opened. A tablespoonful of orange-coloured fluid escaped; and a cavity lined with mucous membrane and along which the finger could be passed for eight inches was exposed. The introduction of a sound showed this pouch to be part of the right ureter. It was freed from its adhesions and cut away, and the end was sutured to the abdominal wound. In a few days intense pain, and a tumour characteristic of hydro-nephrosis, occurred in the right flank, and nephrectomy was performed.

At the time Küster's case was communicated to the Congress of German Surgeons, M. Reynier had under his care at the Hospital Tenon a young man, aged twenty, suffering from uretero-pyelo-nephrosis. On April 27th, 1892, Reynier removed the right kidney of this patient, with 6 cm. of the dilated and inflamed ureter, through a vertical incision in the loin, and fixed the end of the ureter to the lowest part of the wound. Through the end of the ureter he daily irrigated the duct from May 17th to June 29th, without making any improvement in the ureteritis. He therefore, on June 29th of the same year, excised about 12 cm. of the abdominal portion of the right ureter by re-opening the lumbar incision and making considerable traction on the duct, until he drew out 15 cm. of it, dilated and of the size of the small intestine. Under the strain the ureter broke, leaving 12 cm. in his hand, and the rest retracted into the wound and he could not pick it up again. He describes the dissection as long and laborious, and after fruitlessly seeking for the lower end of the ureter he decided to leave the removal of it for a future operation. The wound did not do well, and the patient continued to pass a large quantity of pus in the urine. The pus was intermittently, not daily passed. Sometimes the urine would be quite clear for several days, and then, without apparent cause, it would become thick with pus and so continue for days. So it continued from June to November. On July 5th he decided upon removing the pelvic part of the ureter by the para-rectal incision of Wölfler, but after a very long search did not succeed in finding it; so on November 18th, 1892, he made an incision parallel to Poupart's ligament, exposed the external abdominal ring, opened up the inguinal canal on a grooved director, and guided by the vas deferens—which with the peritoneum he raised up from the wall of the pelvis—he found the ureter and removed the remnant of it, which in length was about 12 cm. It was enormously distended with pus, which could be made to escape into the bladder by pressure. The discharge of pus with the urine immediately ceased after this last operation, and the lad ultimately completely recovered.

Thus in a piecemeal manner at three separate operations, Reynier effected a complete nephro-ureterectomy. The case was reported to the Surgical Society of Paris on February 15th, 1893, and was published in *La Semaine Médicale* of February 24th, 1893.

A further step was gained when Israel, on April 17th, 1893, though he did not remove the ureter, showed in the case of a young man with the symptoms of renal calculus that the ureter in its whole length could be exposed by the extra-peritoneal curvilinear incision, which he had previously described in his article on "Renal Operations."

On February 22nd, 1893, M. Tuffier* excised the right kidney, and with it a considerable length of the abdominal section of the ureter, for uretero-pyelo-nephrosis in a woman aged thirty. The ureter was the size of a pencil case, and about 4 cm. below the renal pelvis it had a sharp sigmoid curve. The kidney was first removed by the lumbar incision, and then by an extension of the same incision the ureter was dissected free to a point below the sigmoid (S) curve, ligatured and cut across. The woman recovered.

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* Tuffier: Congress of French Surgeons, 1893.

In October, 1893, M. Poncet removed at a single operation the whole of the right ureter of a woman aged twenty-eight for tuberculous ureteritis and peri-ureteritis. Two years and a half previously (March 5th, 1891) he had removed the right kidney of the same patient for tuberculous disease. M. Poncet's operation was the first complete ureterectomy and was *retro-peritoneal,* through an incision extending from the fistulous opening in the loin to the anterior superior spine of the ilium, and prolonged forwards and downwards 5 to 6 cm. further. The middle point of this incision was opposite the anterior superior iliac spine and 12 to 15 mm. to its inner side. The patient recovered and returned to her home on January 4th, 1894. The case was published in a thesis by Dr. Jean Liaudet in 1894.

In the *Bulletin of the Johns Hopkins Hospital* for February-March, 1896, Dr. H. A. Kelly records three operations under the title of "Nephro-ureterectomy—Extirpation of the Kidney and Ureter simultaneously." Two were performed by a retro-peritoneal incision, supplemented in one of them by a vaginal incision. The third was a trans-peritoneal operation. All were successful.

In the first case the left kidney and the enlarged ureter down to a point 4 cm. below the pelvic brim were removed together. The date of the operation was March 30th, 1893. The method employed was *trans-peritoneal,* through an incision, 16 cm. in length, on the outside of, and parallel to the left semilunar line; it necessitated the division of the ovarian vessels, and a second long incision through the peritoneum, covering the posterior abdominal and pelvic walls, in order to expose the ureter. Six weeks later an attempt to remove the lower end of the ureter by a vaginal incision failed. The kidney was cystic and tuberculous, and the ureter was converted into a large thick tuberculous cord, at one point undergoing calcification. The woman recovered, and three years after was alive and well except for one of her former discomforts—frequency of micturition. The age of the patient is not stated.

In the second case also, a left nephro-ureterectomy was performed; the patient was an unmarried woman, aged twenty-three; the date of the operation, December 18th, 1895. The case was diagnosed as tuberculous disease of the kidney and ureter. The method of operating was *retro-peritoneal;* "the incision commenced just in front of the vertical muscles of the back at the costal margin, and was carried down towards the middle of the crest of the ilium, and then in a gentle curve around the anterior superior spine, 2 cm. away from it; and from this point in an oblique line down to the lower terminus of the left semilunar line, an inch above the symphysis pubis." The ureter was ligatured close to the bladder and removed entire together with the kidney. No ligatures were required for any vessel between the renal and the uterine arteries. The uterine vessels were divided between two ligatures on the outer side of the ureter and between it and the pelvic wall. The patient made a good recovery.

The third case occurred in a woman aged thirty; the date of the operation is not stated. The method was *retro-peritoneal, partly abdominal and partly vaginal.* Owing to the great amount of fat and the small size of the ilio-costal space, the incision in the loin was a horizontal one, extending 16 cm. across the abdomen in the umbilical line, reaching almost to the right linea semilunaris. Through this incision, not only was the kidney enucleated, but the peritoneum of the pelvis was peeled up, the broad ligament entered, and the viscera pushed aside sufficiently to allow of the ureter being freed down to its vaginal portion, where it was ligatured and cut across. The vesical end was immediately afterwards removed through an incision in the vault of the vagina. The patient recovered completely.

On November 13th, 1896, Dr. A. G. Gerster, of New York,* performed total secondary ureterectomy on a young man aged twenty-six. The cause of the operation was a discharging purulent fistula following nephrectomy which had been performed in the summer of 1893 for pyo-nephrosis.

The method of operating was by the *extra-peritoneal lumbo-iliac* route, with an incision vertical to the oblique one near the posterior end of the latter. It was impossible to find the renal end of the ureter, which was embedded in a large and dense mass of cicatricial tissue; so it was sought for and found on the under aspect of the peritoneum lower down. The ureter was much distended, admitting near the bladder the ends of two fingers above a narrow stricture in the tube an inch above the vesical wall. The ureter was cut away close to the bladder. The operation lasted nearly two hours. The patient was much collapsed after it, and for forty-eight hours was in a critical condition. Ultimately he recovered, and was well on January 27th, 1897.

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* *Annals of Surgery,* September 1897, p. 361.

Dr. McCosh* referred to a case of advanced tuberculous kidney with perinephric abscess in which he performed primary complete ureterectomy, or rather nephro-ureterectomy with complete removal of the ureter. The date of the operation was about April, 1896. The method of operating was the *extra-peritoneal lumbo-iliac* route. In making the incision for opening the abscess, he came down upon the ureter, which looked like the small intestine and was full of pus. An obstruction (probably a stricture) existed in the ureter about half an inch from the bladder.

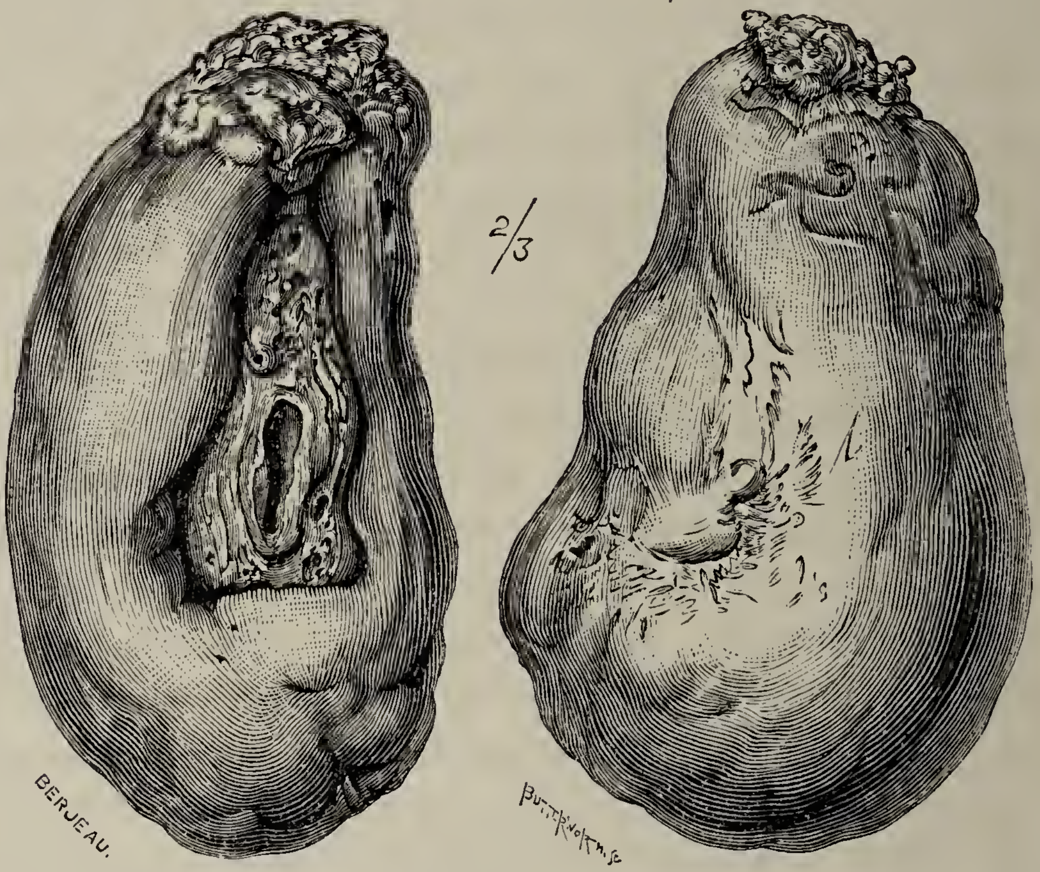

Fig. 200.—The greater part of the left Kidney removed during life for Tuberculous Disease together with the whole of the Left Ureter, which is shown in next Figure. A portion of this kidney had been removed some months before by Mr. Swain of Plymouth, and the wound in the organ had completely cicatrised. (Author's case.)

Dr. McCosh began the operation proper by dividing the ureter at its entrance into the bladder, and, following it up, excised the entire ureter and the entire kidney. The patient recovered, and was then in excellent health.

Dr. McCosh also referred to a case of complete secondary ureterectomy performed by him about two years before, for a lumbar fistula due to tuberculous ureteritis following nephrectomy for tuberculous disease of the kidney. He could not find the renal end of the ureter, but, finding the vesical end, followed it up to the cicatrix. The result is not stated.

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* *Annals of Surgery*, September, 1897, p. 364.

Israel, in a recent communication,* refers to three cases in which he has extirpated the ureter for multiple calculi, the ureters being filled with stones; and two cases of extirpation for tuberculous disease, in one of which the entire ureter and in the other a segment of the duct was removed.

E. Garceau, in 1897, performed nephro-ureterectomy by the combined extra-peritoneal, abdominal, and vaginal method, as Kelly had done.

I have in one case removed the kidney (Fig. 200) and the entire ureter (Fig. 201) for tuberculous disease; † in another case nearly the entire ureter for a continuing fistula after injury (*see* p. 349, Vol. II,, Fig. 152); in another the renal capsule (left after a sub-capsular nephrectomy) and more than half the ureter (*see* Fig. 202); in another case I removed the lower four inches of the ureter by the sacral route, having twenty days previously removed the kidney, together with the abdominal and part of the pelvic portions of the ureter, for calculous ureteritis and pyo-nephrosis; and in a number of cases in and since 1895 I have taken away the ureter as low down as the brim of the pelvis when performing nephrectomy for tuberculous disease or calculous pyo-nephrosis.

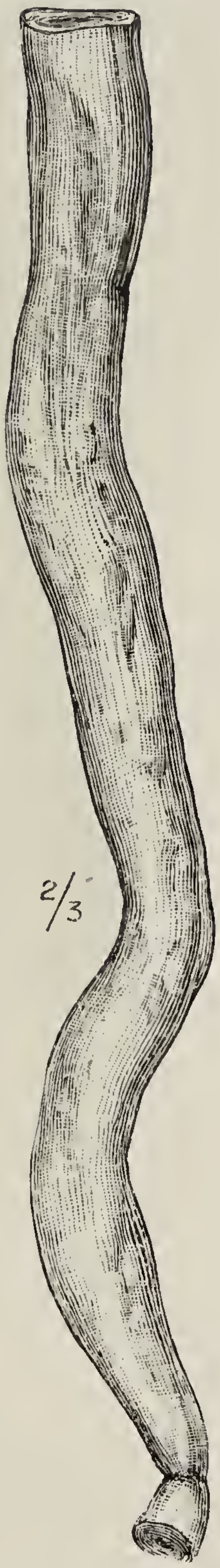

Fig. 201. — Complete Nephro-ureterectomy of Left Ureter. (Author's case.) A part of the kidney had previously been removed by Mr. Swain of Plymouth.

Elliot ‡ performed retro-peritoneal extirpation of a kidney with its ureter on an unmarried woman aged twenty-four who suffered from severe abdominal pain. A laparotomy was performed, and the appendix was examined and found healthy. Later on another laparotomy was performed and the kidneys palpated. A fluctuating swelling was then found at the outer border of the right kidney, and this was drained by a lumbar incision. The wound healed, but the pain returned upon both sides. Double nephrotomy was then performed, and the pain relieved, but a urinary fistula was left upon the right side. The patient then lost flesh, and was unable to work on account of the fistula. Mr. Elliot decided to perform nephrectomy. A most careful examination was made of the condition of both kidneys. The whole of the urine of the right kidney was passed from the loin, and contained one-seventh of the total secretion of urea, a quarter of albumen, and was of low specific gravity and loaded with pus. The urine from the bladder contained six-sevenths of the urea (294 grains), and was clear and of specific gravity 1026, with only a trace of albumen. The patient improved much during her stay in the hospital, and the percentage of urea rose to 2·44 per cent.

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* *Berlin. klin. Wochensch.*, February 27th, 1899.

† *Lancet*, January 1st, 1898.

‡ *Boston Medical and Surgical Journal*, February 25th, 1897.

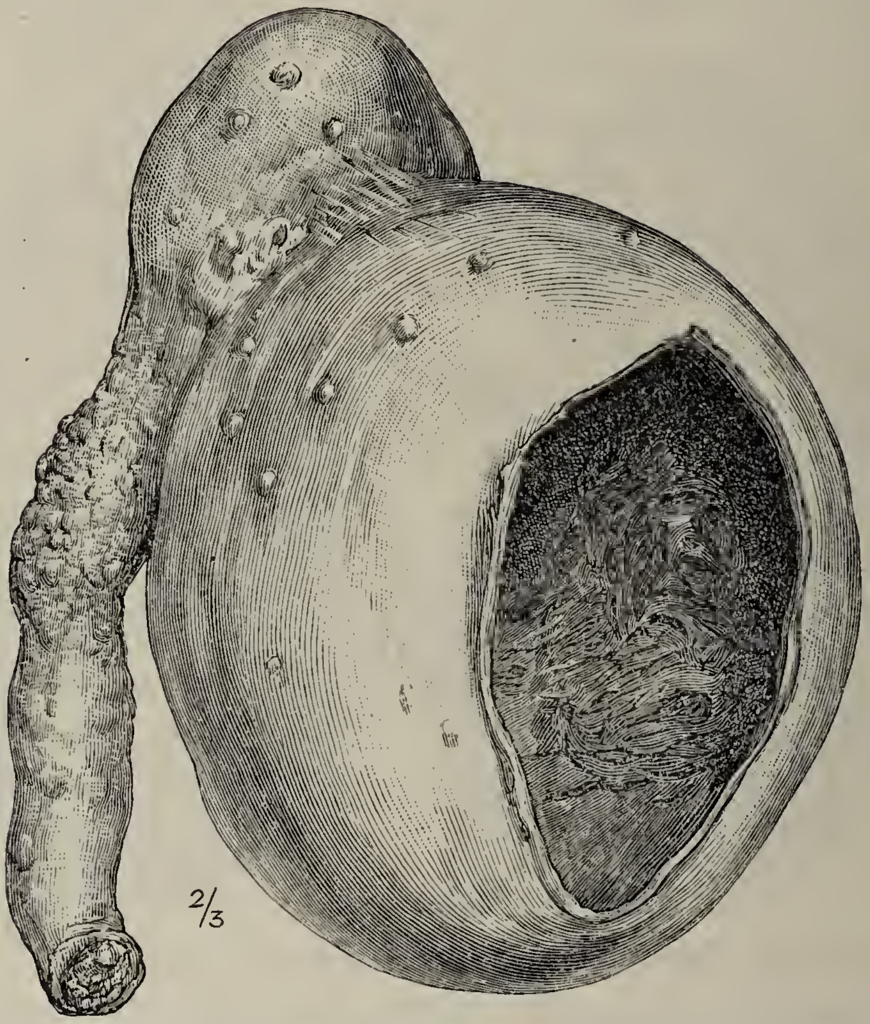

Fig. 202.—Partial Ureterectomy with the removal of the Renal Capsule, which had been left behind after a sub-capsular nephrectomy had been performed one month previously. (Author's Case.) ("Hunt. Lect.," Table vii., Nos. 20 and 21.)

The operation was by the usual lumbar incision, but this was afterwards extended forwards to the abdomen. The right kidney was first removed, and the ureter was found dilated and thickened. A sound was passed down it and reached the bladder without touching a stone. The dilatation of the ureter ceased where the duct passed over the brim of the pelvis. Here it was divided, and its mucous membrane was sutured and turned in as after removal of the appendix cæci. The whole of this operation was *extra-peritoneal*, although the peritoneum was twice torn and sutured. The wound was drained by a gauze drain and after some time healed. The bladder was drained after the operation by a catheter, but uræmic symptoms seemed to be produced by this procedure, although the excretion of urea was better than before the operation. The patient recovered, and was shown seven months later "the picture of health" and doing full work. The total of urea secreted by the one kidney greatly exceeded that by the two before the nephrectomy.

Hartmann reported to the Congrès Français de Chirurgie, 1897, a case in which he performed complete secondary ureterectomy on January 14th, 1897.

This is in one respect one of the most extraordinary cases on record, because, after nephrectomy, the whole of the urine from the left kidney is described as passing along the right ureter and escaping at the fistulous opening in the right loin, without the patient being able to expel a single drop by the urethra.

The patient, a woman aged thirty-five, a typical neurotic, had for years complained off and on of abdominal pains, and of attacks referred at one time to the bladder, at another to the kidney or uterine appendages.

She was married when twenty-one years of age, had been confined three times, and at some little time after each confinement her symptoms were aggravated. Seven weeks after the third confinement nephrotomy was performed (February 2nd, 1895), and the kidney was found dilated but not suppurating. Temporary relief followed but was not maintained, and a lumbar fistula formed. In the end of the following year she was confined to bed with great pains in the bladder and right side of the abdomen, constant flow of urine and pus from the fistula, and an abscess which formed at the side of the fistula. In this state right-sided nephrectomy was performed, and the upper end of the ureter was fixed to the skin in the loin (November 28th, 1896). The kidney removed was small, showed the changes of partial interstitial nephritis, and its calyces communicated with the fistulous canal.

After the nephrectomy, thinking to improve the ureteritis by disinfectants, which evidently still persisted, Hartmann catheterised the ureter from the loin. After the first introduction of the catheter all the urine of the left kidney passed along the right ureter and escaped by the fistula in the right loin, not a single drop passing along the urethra.

For this condition the entire ureter was removed (January 14th, 1897) within two months after the nephrectomy. The fistulous orifice was dissected out with the ureter as low down as the bladder. The ureter was ligatured close to the bladder, and the stump cauterised and dropped back into the depth of the wound. The incision employed was the oblique lumbo-ilio-inguinal. The method was entirely *extra-peritoneal,* but the peritoneum was torn near the broad ligament and closed by fine silk sutures.

The indications for the operation are :—

1. *Tuberculous disease* of the ureter, the primary seat of the affection being situated in the kidney of the same side. These are the cases which will most frequently and most urgently require ureterectomy ; and for three reasons : first, because nephrectomy is sometimes insufficient for the cure of the disease or even for the relief of the symptoms ; second, because nephrectomy in these cases is apt to be followed by a persistent fistula ; and third, because if the disease in the ureter continues, or worse still progresses, there is risk that it will spread to the bladder from the lower end of the affected ureter and subsequently give rise to ascending tuberculous infection of the opposite ureter and kidney.

In performing nephrectomy for tuberculous kidney the ureter should always be examined and removed if diseased.

2. *Chronic ureteritis with dilatation and persisting suppuration* from any cause, be it renal calculus, or stricture or ulceration of the ureter. Not unfrequently a fistula due to suppurative ureteritis persists after nephrotomy or nephrectomy, whether done for calculous pyo-nephrosis, ascending puerperal uretero-pyelo-nephritis, or pyo-nephrosis from ureteral stricture caused by old-standing peri-ureteritis.

In such cases secondary ureterectomy is often the only means of curing the fistula. When in the course of a nephrectomy the ureter is seen to be dilated and inflamed it will be wise to remove the upper 4 or 5 inches of the tube with the kidney, and unless the rest of the ureter is healthy, to be prepared to perform complete ureterectomy, either at the same time or at a subsequent period.

3. *Tumours or cancer of the ureter* will seldom be detected soon enough to be treated advantageously by partial ureterectomy, but if diagnosed before the disease is beyond the limits of operation a partial ureterectomy going wide of the growth should be practised. It would depend upon the part and the extent of the

ureter involved whether nephrectomy, or uretero-ureteral anastomosis or the establishment of a cutaneous fistula, should be simultaneously performed.

4. *Ascending suppurative ureteritis with pyo-nephrosis* due to a urethral prostatic or vesical cause may occasionally require nephro-ureterectomy. Such cases are not as a rule suitable for the operation, because too often the ureteritis from these causes affects both ureters. But when the ureter and kidney of one side only are involved and the original cause of the disease has been removed, nephro-ureterectomy will cure the patient.

5. *Hydrops of the ureter* associated with frequent painful micturition, requires nephro-ureterectomy if the cause of the obstruction cannot be removed; and even if it can be removed the operation may be necessary if the kidney also is dilated or atrophied.

6. *Partial re-section of the vesical end of the ureter* may be effected by the hypogastric route as part of an operation for excision of a malignant tumour of the bladder; but if this is done nephrectomy or some form of grafting or anastomosis must follow.

Thus, ureterectomy may be either partial or complete, primary or secondary. When the ureter is removed simultaneously with the kidney the operation is known as nephro-ureterectomy or primary ureterectomy. When the ureter is excised at a subsequent operation, nephrectomy having been previously done, it is spoken of as secondary ureterectomy.

Partial ureterectomy is not the same thing as re-section.—Re-section is the removal of an inch or more of the tube, followed by the union of the divided ends and the restoration of the kidney function; but the excision of several inches of the tube, for one or other of the causes above enumerated—partial ureterectomy—is necessarily followed by a .ureteral fistula or the loss of the kidney.

Partial ureterectomy will generally concern the renal end of the tube, and will be performed at the same time as nephrectomy. When this has been done the inferior portion of the ureter may have to be removed at a future operation, as in Reynier's pioneer case, or it may not.

In the exceptional event of excising only a portion of the pelvic or lower abdominal tract of the ureter, either the kidney would have to be sacrificed or a cutaneous fistula established.

As to whether primary or secondary ureterectomy is best, the following considerations will guide us. If during the course of nephrectomy the ureter for some inches from the renal pelvis is seen to be in a dilated and suppurating condition, or affected with tuberculous disease, the rule ought to be to excise the affected part of the ureter together with the kidney; but if there is evidence from the history and symptoms, and from the conditions found at the time of the operation, that the great part or the whole of the ureter is in a similar state, the surgeon must be guided by the condition of the patient. If this is not good it will be best to remove the kidney, and wait until the patient has recovered from the nephrectomy before excising the ureter. If the condition of the patient warrants it the ureter should be at once removed, *i.e.* primary ureterectomy should be performed.

Complete ureterectomy is no doubt a severe operation in many cases, attended by great difficulties and risks; and as it is possible that a perfect cure of ureteritis may follow nephrectomy alone, it will often be wise not to expose the patient to the more severe operation, nephro-ureterectomy, until it has been proved that this favourable result will not be obtained. Besides, most probably, the patient's general health will improve after the nephrectomy, and he will be in a better condition to recover from a secondary ureterectomy after waiting for a time to convalesce from the nephrectomy.

Thus then, while primary partial ureterectomy should be the rule when the removal of the abdominal portion only of the ureter is the operation required, secondary ureterectomy is frequently safer than primary ureterectomy when the whole or nearly the whole of the ureter has to be removed.

It is often far from easy, when as a result of perinephritis of long standing the kidney is surrounded and the hilum of the organ filled with tough fibro-lipomatous tissue, to make out the upper end of the ureter. This should always be done when possible, if only for the purpose of sounding the ureter. If however the surgeon fails to isolate the infundibulum before cutting away the kidney, he may not be able to find the ureter afterwards in this dense tissue, but will have to seek it lower down at the pelvic brim. This would be an additional reason for postponing ureterectomy till the patient has recovered from the nephrectomy.

METHODS OF OPERATING; THE EXTRA-PERITONEAL OR LUMBO-ILIO-INGUINAL OPERATION.

Partial ureterectomy, when the kidney also is to be removed.—In the course of nephrectomy the renal vessels should be sought for and ligatured separately from the ureter. When this has been done they should be divided so as to free the kidney. The ureter should then be put on the stretch by dragging upon the kidney.

If the tissues are yielding, the ureter may be separated from its connections by the finger; if tough and adherent, then it must be dissected away from the surrounding cellular tissue and peritoneum with great care.

To do this the usual oblique incision in the ilio-costal space for exposing the kidney must be prolonged forwards as much as may be required (*see* Fig. 122, p. 132, Vol. II.). Then the peritoneum, and the colon with it, must be raised inwards towards the spinal column. The ureter is always adherent to the back of the peritoneum, and is raised with it. It is in a sheath of cellular tissue which is intimately blended with the deep aspect of the peritoneum, and when this sheath is sclerosed and adherent, very careful dissection is needed to free the tube from the serous membrane.

As soon as the ureter is free for the length it is intended to excise, it should be secured with a catgut or fine silk ligature below the proposed point of division, and by a pair of compression forceps applied about an inch above the point of ligature. The ureter is then divided between the ligature and the forceps. Some iodoform gauze should be temporarily packed about the ureter, where it is to be divided so as to absorb any of the contents of the tube when it is cut across.

When the kidney is very much enlarged it may be better to clamp the renal pedicle and remove the kidney before ligaturing the vessels and dissecting out the ureter.

In other cases, though the structures at the hilum may be very pliable and soft, the renal pelvis may be so widely expanded that the renal vessels are quite overspread by it. In this condition it will be requisite to transfix the renal pelvis in order to tie the pedicle, unless some manœuvre be employed to secure the vessels alone. It is in these cases all the more desirable to secure the vessels separately, not only from the point of view of having the renal pelvis free to serve as a guide to the ureter, but because when a great expansion of the renal pelvis is included in the ligatures they are very prone to slip as soon as the kidney is cut away, and then the detached pelvis is apt to retract. To avoid this I have sometimes found it a great advantage to rotate the kidney so that the ligatures can be passed between the front of the expanded renal pelvis and the renal vessels; or else to cut carefully through the renal pelvis, seizing its cut edges with forceps whilst doing so, and then tying the vessels and removing the kidney. When this is done the forceps holding the renal pelvis will subsequently serve as a holdfast during the excision of the ureter. When tough fibro-lipomatous tissue fills the hilum and closely invests the vessels, the pedicle will have to be ligatured as a whole. This often leads to the necessity of ligaturing the vessels again, as they are prone to escape constriction by the transfixion ligatures and to bleed when the kidney is cut away. It is in these cases that the upper end of the ureter may escape detection and ureterectomy may have to be postponed.

If secondary excision of part of the pelvic or lower abdominal sections of the ureter were contemplated, it would be unnecessary to reopen the loin, as the operation should be performed by the retro-peritoneal method along the central or central and lower parts of the lumbo-ilio-inguinal line (Fig. 122, p. 132, Vol. II.). As the ureter will be then sought for where it crosses the iliac vessels, the incision should be commenced with this as its central point, or a little behind it.

Complete ureterectomy.—The patient should be lying on the side, inclined at first somewhat on his face and afterwards somewhat on his back. Two good assistants are required to help the surgeon in the manipulations of the wound. An oblique incision (the lumbo-ilio-inguinal) should be made in the ilio-costal space, commencing just below the twelfth rib a little in front of the outer border of the sheath of the erector spinæ muscles. It should be prolonged forward in front of the anterior superior spine of the ilium and about one inch to its inner side, then inwards parallel to Poupart's ligament and about two inches above it as far as the middle of the ligament, or even as far forwards as the external abdominal ring. This incision will divide the skin, fascia, the three layers of abdominal muscles and their aponeurosis, the transversalis fascia, and the sub-peritoneal fat. It should not be made in its full extent at once; whether the ureter has to be sought for near the kidney or near the iliac vessels, it is only necessary to make the lumbar or lumbo-iliac part at first and prolong it subsequently as the operation proceeds.

The peritoneum must then be carefully raised as in the operation for tying the iliac artery. A large thin flat sponge should be introduced into the wound, and the peritoneum, subjacent intestines, and the inner cut edge of the abdominal parietes should be well retracted inwards by an assistant. If the kidney has been previously removed, or even if part of the kidney remains, the tissues in the renal region may possibly be too condensed to allow of the upper end of the duct being found and traced downwards from the infundibulum. If this cannot be done, it is best to feel for the pulsation of the common and external iliac arteries as they cross the brim of the true pelvis and then to seek for the ureter on the posterior rough aspect of the peritoneum where this membrane has been detached from the vessels.

The ureter will be found covered by its investing sheath of cellular tissue, which holds it against the peritoneum, looking like an obscure bluish-white or bluish-yellow band. Its sheath should be gently scraped through or divided with the scalpel, the tube completely exposed at this point, and then the left index finger or an aneurysm needle should be passed round it. With a little traction on the tube the dissection of it will be made easier. It should be first followed from the pelvic brim upwards and then downwards, taking care all the while to keep close to the wall of the ureter so as to avoid penetrating the peritoneum, but at the same time to avoid piercing the ureter and letting its septic contents escape into the wound. It is better however to do this, or even to leave portions of an adherent tube behind, than to run any risk of opening the colon, and more especially of injuring the vena cava or abdominal aorta.

When the upper end of the tube is reached it should be at once secured by a ligature if it has previously been cut away from the kidney, and at the vesical end two ligatures should be applied at an interval of three-quarters of an inch and the ureter divided between them. The lumen of the vesical portion above the ligature should be well rubbed with iodoform paste or strong carbolic solution, and its walls invaginated and held together by one or more Lembert's sutures passed over the end of the tube.

The wound should then be closed by deep and superficial sutures. If there has been any escape of pus or foul urine into the wound and primary union is not to be expected, one or more drainage tubes should be introduced and allowed to project at the lumbar part of the wound. The deep sutures should be passed through skin, muscles, and fascia; the superficial sutures should be intermediate between the deep, and passed through skin and superficial fascia only. I have long given up using separate sutures for the separate layers of the abdominal wall. They are objectionable as giving a less firm cicatrix and as leading to suppuration between the layers of the wall if any failure occurs in the primary healing of the entire wound

The drainage tubes should remain undisturbed for two or three days and then be gradually shortened or removed entirely.

The sutures should be retained for from eight to ten days at least, and even longer if they are not causing irritation. It is a great mistake to be in haste to remove them. A wound in the loin is liable to be dragged upon in the movement of the patient, and by the nurses in changing draw sheets, etc., so that the longer the sutures are retained the better—until at least both superficial and deep healing is complete.

Precautions in extra-peritoneal ureterectomy.—(1) In the course of the operation the peritoneum may be torn. This occurred twice in Poncet's, and once in both Hartmann's and Elliot's operations. In one of my own cases of nephro-ureterectomy the peritoneum was lacerated in removing the kidney. Should this accident occur the rent must be closed by continuous suture.

(2) After raising the peritoneum and exposing the psoas muscle the surgeon should not mistake the nerves of the lumbar plexus which appear at the outer border of the muscle for the ureter; but should continue the detachment of the peritoneum from off the anterior surface of the psoas and then seek for the ureter on the detached serous membrane.

(3) In separating the ureter keep close to its own walls. It should be remembered that this duct is surrounded in its whole course by cellulo-fatty tissue, and that if this tissue is thickened, indurated, and firmly adherent to it, any force used in isolating the ureter may result in tearing the peritoneum, or even the vena cava or aorta, as the side may be; or the spermatic or ovarian vessels which are in front of the ureter and raised like it with the peritoneum, or in the female the uterine artery and veins may suffer. In the male there are no vessels which are at all likely to be injured in connection with the pelvic section of the tube; but in the female the uterine artery crosses the ureter as they are in relation with the neck of the uterus, and

might possibly give rise to trouble. If the artery is found to be in the way when tracing the ureter onwards to the wall of the bladder, it should be ligatured in two places and divided between the ligatures. If the uterine artery has to be tied, the aneurysm needle should be passed from behind forwards to avoid wounding the iliac vein. Kelly met with this accident in one of his cases.

(4) If in the course of the operation the ureter is torn or punctured, or its upper end unexpectedly becomes free and pus or purulent urine escapes into the wound, extra precautions must be taken by antiseptic swabbing and irrigating to cleanse the parts which have been in contact with the discharge.

(5) If the incision in the abdominal wall is carried forwards much beyond the internal abdominal ring, the deep epigastric vessels will be encountered and will probably require division; if the inguinal canal is laid open, care will be required in operating upon the male to draw the vas deferens away with the upper edge of the wound in separating the peritoneum from the pelvic wall.

The incision above described is pretty much the same as that recommended by Israel for the complete exploration of the ureter, and adopted by Poncet, who was the first surgeon to perform total ureterectomy at a single operation. It is well adapted to meet all the requirements of the operation, without causing unnecessary disturbances to structures. It provides ample room for manipulation and inspection, does not involve the division of any important vessels, affords excellent drainage, and results in rapid healing of the wound. It can be made to give greatly increased room by a vertical cut upwards from it about 2 to 4 cm. in front of its posterior extremity. If it is required to excise the last rib, this second incision instead of being quite vertical should be curved somewhat backwards as it proceeds upwards.

In my original operation on the kidney in 1880 I employed this *oblique lumbo-iliac* incision, and I have steadily used and advocated it ever since, alike for nephro-lithotomy, nephrotomy, and (except when for special reasons I have done the trans-peritoneal operation) for nephrectomy. It is equally convenient for exposing the first portion of the ureter or for exploring the kidney, and can be readily prolonged in the anterior direction over the course of the ureter as more of the duct requires to be exposed.

Israel commences his incision a finger's breadth below the last rib on the outer edge of the mass of spinal muscles, and continuing it parallel to the last rib as far as its tip, directs it afterwards towards Poupart's ligament, and then curves it inwards to end upon the outer border of the rectus muscle. There is great variation in the length and obliquity of the last rib, and to follow its line would often be to make the incision too horizontal.

My incision is more oblique in its ilio-costal part, and excepting as a guide for the commencement of the incision, I disregard the last rib entirely unless I intend to excise it, and then I make the slightly curved vertical incision above mentioned.

Some operators prefer to make the lumbar part of the incision vertical, starting from the twelfth rib or a little below it, and running it parallel to or along the outer border of the mass of spinal muscles nearly down to the crest of the ilium, then curving it forwards in front of the anterior superior spine of the ilium. It is claimed for this incision that (1) it gives more room (i.) by enabling the surgeon to pull aside the border of the erector spinæ muscles, which are said to obstruct the view of the upper part of the wound, and (ii.) by forming a flap which can be pulled upwards and forwards; (2) it necessitates a less extensive detachment of the peritoneum along the course of the meso-colon; (3) it exposes only the lower part of the colon, and preventing it from prolapsing, thus offers less chance of cutting it across; and (4) it is more in the course of the first part of the ureter.

In my opinion these advantages are theoretical rather than real; whilst, on the other hand, the incision leaves an awkwardly shaped wound to bring together, and is not so convenient for excising the last rib if this is found necessary; nor for separating the kidney, especially if the organ is situated well under cover of the ribs.

That portion of the oblique incision between the last rib and the front of the anterior superior spinous process affords by far he best opening for exposing and enucleating the kidney, and, if the parts about the hilum permit of the ureter being traced downwards from it, of readily exposing the abdominal portion of the ureter also; whereas if the density of the fibro-lipomatous tissues and the toughness of the adhesions about the hilum and renal end of the ureter do not allow of the ureter being traced from above, the place to seek for the tube is where it crosses the iliac vessels on the deep surface of the peritoneum, and this is readily done through the same incision, prolonged a little forwards if requisite.

If there is difficulty in freeing the kidney owing to its high position beneath the lower ribs, much additional room is gained by making a vertical incision *upwards* over the last rib from the oblique incision, about 2–4 cm. in front of its posterior extremity; and this facilitates the excision of the last rib, as stated above. A little more space for manipulations in the depth of the wound can be gained by cutting the outer border of the sheath of the erector spinæ muscles without cutting the muscles themselves. It is the sheath more than the muscles which offers resistance to the retractors and restricts the movements of the operator's hand; and if this is incised the muscles themselves yield and can be drawn aside by a retractor. After the operation one or two fine, buried sutures suffice to unite the cut edges of the sheath. As regards the colon and peritoneum, these, if normally connected, are often not even seen in the enucleation of a kidney; and if the colon should project into the wound it can easily be kept out of the way by a retractor and a sponge. Moreover, if a previous operation has been performed upon the kidney, or if there has been much chronic perinephritis and peri-ureteritis, the ureter may require to be dissected away from the peritoneum and colon, as was the case in one of my own operations; and under such circumstances the more clearly these structures are seen the better.

Other extra-peritoneal methods of performing ureterectomy.—Besides the lumbo-ilio-inguinal operation above described, other extra-peritoneal methods have been employed.

1. Regnier, in his pioneer operations, removed 6 cm. of the ureter with the kidney through *a vertical lumbar incision.* This incision was made 8 cm. from the line of the spinous processes and parallel to the sacro-lumbar muscular mass, starting at the eleventh rib and ending at the iliac crest. Along the same line, two months later, he removed 12 cm. more of the ureter. He cut along the old cicatrix, detached the fistulous orifice, and dissected up 5 or 6 cm. of the ureter with its cicatricial fibrous investment; it then became easy by simple traction to draw out of the wound 15 cm. of the duct. He followed with his finger the detached ureter as low as the upper aperture of the true pelvis, and when about to apply a ligature upon it as low down as possible, the

ureter broke and the lower end retracted into the wound; as he could not find the end, it was, after a considerable search, left unremoved. This shows the disadvantage of the vertical lumbar incision for the removal of the abdominal portion of the ureter, and for ligating the tube near the brim of the pelvis; by the lumbo-iliac incision prolonged into the inguinal region the lower part of the ureter might have been removed at the same operation.

Regnier distinctly states that the dissection of the ureter was "long and laborious."

His later attempt to find the remnant of the ureter by seeking for it at the back of the bladder was made by means of a *perineal incision.* The incision was 10 cm. long, at a distance of two centimetres from the middle line, reaching posteriorly the level of the coccyx. Though by this route he gained the sides of the rectum and prostate, and could feel easily the seminal vesicles and the *bas-fond* of the bladder, it was impossible to see or feel the ureter amid the mass of fatty tissue which surrounded it and the coils of small intestines which came in contact with the finger.

Regnier's last and successful trial to remove the pelvic portion of the ureter of this patient was by *laying open the inguinal canal with the intention of taking the vas deferens as his guide to the position of the ureter.* He made an incision somewhat different from the anterior part of the lumbo-ilio-inguinal line, which is described and shown on p. 132, Vol. II. (Fig. 122). The bladder was injected with boric solution, the rectal bag introduced and distended, then an incision was made in the direction of the inguinal canal, nearly parallel to Poupart's ligament 12 cm. in length, commencing 1 cm. from the pubic spine and 2 cm. above the inner end of Poupart's ligament. The incision, in fact, started from the external abdominal ring, and the wall of the inguinal canal was incised in its whole length, upon a grooved director introduced at the external ring; but the vas deferens and the ureter were detached and raised with the peritoneum, and were only discovered on releasing the peritoneum from the retractor which was displacing it.

The ureter was then traced to the side of the bladder, where it was ligatured and cut away.

This operation showed the unreliableness of the vas deferens as a guide to the ureter.

The proper place for finding the duct will always be the outer or detached surface of that part of the peritoneum which covers the commencement of the external iliac artery.

2. Howard Kelly has employed a combined abdominal and vaginal method—an entirely extra-peritoneal operation.

The abdominal incision began in front of the posterior vertical muscles and extended 16 cm. across the abdomen in the umbilical line, reaching almost to the linea semilunaris. Numerous bleeding vessels were clamped and tied with catgut. By drawing the kidney down over the lower lip of the incision the renal vessels were exposed, tied with a silk ligature, and cut short. By pulling on the kidney and ureter the latter was made tense and easily dissected out of its cellular bed with the index and middle fingers. The ureter was further freed down to the broad ligament by introducing the entire hand into the retro-peritoneal cellular tissue, and detaching the duct with the tips of the fingers. It was then ligatured and divided just above the broad ligament.

The vagina was now thoroughly disinfected, and, with the patient still lying on her left side, an opening was made into the vaginal vault, through which the end of the ureter was brought and clamped with a pair of forceps until the abdominal wound was closed.

The vaginal opening was made by passing the entire left hand through the abdominal wound down into the pelvis, and pressing the index and middle fingers against the right vaginal fornix, at the same time lifting up the uterine artery on the index finger, so as to avoid any danger of cutting it. The index and middle fingers of the right hand were now introduced into the vagina (the patient still lying in the left lateral posture) and pressed up against the fingers of the left hand in the abdomen, the palmar surfaces of both hands being turned upwards. The opening of the vault necessary to draw the end of the ureter into the vagina was now made by an assistant who introduced a pair of sharp-pointed scissors along the surgeon's fingers up to the vaginal vault and pushed them through the thin septum; he then spread the blades of the scissors and withdrew them, in this way enlarging the hole in the vault to about 2 cm. The opening was situated about 2 cm. to the right of the cervix. The bleeding from this torn wound was venous and slight. With a pair of forceps pushed through the vaginal opening, the ligature attached to the ureter was now caught and the ureter drawn through into the vagina.

The patient was now placed in the lithotomy position and the extirpation of the remainder of the ureter was effected *per vaginam.* The end of the ureter and the hole in the vault were exposed by using retractors and catching the right side of the cervix with a bullet forceps and drawing it strongly to the left side. The incision in the vaginal wall, at first at the side between the anterior and the lateral walls, was then carried forwards under the base of the bladder to a point within 1½ cm. of the end of the ureter in the bladder. There was a free venous oozing from the cut vagina below the vault. The ureter broke twice; the second time at the vesical extremity, and, as the end could not be found again, the wound was closed and the bleeding stopped by introducing about six catgut sutures and tying them tightly; the hole in the vault communicating with the extensive cellular tissue area above was left open for drainage, a piece of iodoform gauze being inserted into the cavity, and its end left hanging down in the vagina.

It will be noticed that the ureter broke twice during the course of the vaginal portion of the operation, that the second break was near the bladder, and the torn end could not be found but had to be left unsecured. Such an accident might give rise to the most serious consequences from urinary extravasation and pelvic cellulitis and abscess. The patient was undoubtedly exposed to the risk of backward extravasation of urine from the bladder through the stump of the ureter—a possibility which the researches of Lewin and Goldschmidt, of Guyon and Constade, show to be a reality in the rabbit and dog as a consequence of certain conditions of tonicity of the bladder; and which actually happened in the case of a woman with a fistula following a nephrectomy for uretero-pyelo-nephritis, performed by Desnos,* and in another case recorded by Hartmann.

In one of his cases Kelly failed altogether in his attempt to remove the lower part of the ureter by the vagina.

Dr. Edgar Garceau † of Boston in 1897 performed this combined extra-peritoneal abdominal and vaginal method on a woman aged twenty-two for tuberculous disease. The patient did badly after the operation, and the fistula did not close till nine months afterwards.

Objections to the combined abdominal and vaginal operation. —(1) The line of incision of the abdominal wall gives far less facility for manipulating the ureter in its pelvic portion than the lumbo-ilio-inguinal. This objection could be met, of course, by employing the latter incision. (2) The difficulty and awkwardness of the vaginal part of the operation, owing to the narrowness of the sphere for operating. (3) The risk of breaking the ureter by traction and the dangers attending this accident if the vesical end cannot be secured, viz. extravasation of urine, and pelvic cellulitis and abscess. (4) The possibility of hæmorrhage from the venous plexus surrounding the lower end of the ureter. (5) The probability of not finding the ureter at all through the vaginal route.

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* *See* Glantenay, p. 268.

† *Boston Med. and Surg. Journ.*, Dec. 28th, 1899.

It is only when adhesions exist in the pelvis, making it impossible by the extra-peritoneal abdominal route to separate the layers of the broad ligament and thus to reach and isolate the ureter, that the vaginal method should be even for a moment considered. At best it is only the lowest three inches or less which can be dealt with; and the space for operating between the cervex uteri and vagina on the one hand, and the wall of the pelvis on the other (normally about 4 cm.), is very small, and may be further contracted by old cellulitis and visceral adhesions. Considering how often a remnant of tuberculous disease aborts and the affected organ undergoes spontaneous cure after the removal of the chief part of the disease, it is often well to leave the lowest few inches of the ureter untouched and to be content with the removal of so much of it as can be completed through the lumbo-ilio-inguinal incision. If from any cause the lowest three or four inches must be excised and cannot be satisfactorily reached through the lumbo-ilio-inguinal route; or if the abdominal and a portion of the pelvic segments of the ureter have already been removed, the *sacral method* will be better than the vaginal.

TRANS-PERITONEAL URETERECTOMY.

The trans- or intra-peritoneal operation has been performed through a parietal incision along the linea semilunaris. As soon as the peritoneal cavity is entered the viscera are displaced to the opposite side of the abdomen, and are there retained by one or more flat sponges. The posterior peritoneum is cut through along the outer side of the colon and raised with the bowel, which is also displaced towards the opposite side of the spinal column. Thus a way is cleared to the ureter where it lies on the psoas muscle. If the ureter is enlarged or indurated it may be easily found, and can then be traced up to the kidney; but what can be much more readily done in the majority of cases is to find the hilum of the kidney and to trace the duct downwards from the renal pelvis. The kidney is enucleated, the renal vessels tied, and the ureter—made taut by gentle traction upon the detached kidney—is freed as far as the pelvic brim or even lower, as the case may be. If the separation must be made as far down as the broad ligament, the ovarian vessels will probably have to be ligated and divided. The mucous membrane of the stump of the ureter should be freshened and stitched, or sterilised with the thermo-cautery. It is not necessary to suture the posterior layer of the peritoneum.

Objections to the trans-peritoneal method.

1. Besides the necessity of a second extensive incision through the peritoneum, in the female the division of the ovarian vessels is generally also requisite.

2. In the female, it is very probable that as it courses through the broad ligament the ureter will be surrounded by such dense cellular and fibrous tissue that it cannot be enucleated by any manipulations from within the peritoneal cavity.

3. If the ureter is removed close to the bladder the uterine vessels will be likely to require division.

4. There is the danger of fouling the peritoneum by the escape of the ureteral contents should the ureter be damaged by traction upon it, or in the process of dissecting it, when adherent, from the parts around.

5. There are parts of the ureter hidden both from view and from direct palpation on the peritoneal side; this is especially the case with the pelvic part of its course in the female, and the portion near the renal pelvis in both sexes and on both sides of the body. In front of the ureter on the right side there are the second portion of the duodenum, the ascending colon at the insertion of its meso-colon, and the cæcum; on the left side the splenic flexure, the descending colon, and the sigmoid flexure are before it.

6. In addition to the spermatic colic, ovarian and uterine vessels, there are numerous veins—some of them at times of very large size—passing in front of the lumbar section of the ureter. The veins are likely to embarrass the surgeon, because one of them may be mistaken for the ureter or the ureter mistaken for a vein.

7. Perhaps one of the greatest practical objections to the trans-peritoneal operation is that if the ureter cannot be felt or seen through the undisturbed serous membrane and cut directly down upon, the peritoneum along the outer border of the colon has to be incised and raised; the ureter then, instead of being seen on the surface of the psoas, requires to be carefully sought for on the posterior aspect of the raised serous membrane. To find it in this position from the abdominal cavity is not easy or commodious; whereas from the loin the surgeon is looking directly upon the outer surface of the peritoneum to which the ureter is attached.

The trans-peritoneal method is neither satisfactory nor efficient for exploring the kidney, but it is even less satisfactory and less efficient for exploring the ureter. It ought to be absolutely abandoned in ureterectomy, and only employed, if at all, for merely examining the ureter or kidney when it is desirable to ascertain the condition of the organs of both sides at the same time. Even for this purpose it is very unreliable, and if it be found that an incision into the ureter or kidney is required, the abdominal wound should be closed and the operation performed through the retro-peritoneal route.

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